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Herkese Merhabalar,

On on yedinci yılımızın özel sayısında toplam 20 makale yer almaktadır.

Bu sayıda katkıda bulunan gerek yazarlarımıza gerekse hakemlerimize çalışmalarından dolayı teşekkür ederiz.

Saygılarımla.

Editör

Dr. Hülya GÜR

Preface

Greetings to everyone,

In this edition of our journal, we have a total of 20 articles related to science and mathematics education.

Thanks to everyone for contributing and/or becoming the reviewer of our journal.

Editor

Dr. Hülya GÜR

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Review

Accommodation Problem of Higher Education Students from the Past to the Centenary of the Turkish Republic

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Abstract – Türkiye has gone through a significant expansion process in its higher education system, especially since the beginning of the 2000s. However, this expansion brought with itself the problem of student accommodation. This study examines the accommodation problem of Turkish higher education students who have to abandon their hometowns to live in cities where they get an education. The method used is document analysis including refereed journal and newspaper articles, national and international reports and statistics and various online sources. They referred to the proclamation of the Turkish Republic in 1923 and covered the centenary of the Republic in 2023. Briefly, the key findings noted the inadequate bed capacities in university and state dormitories, dramatic increases in the cost of accommodation, and architecture and management problems in dormitories that negatively affect the service quality and the daily routines of students. For a more thorough analysis, a mixed-method study is suggested for future researchers.

Key words: higher education students, accommodation cost, dormitory capacities, dormitory management, centenary of the Turkish Republic

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Introduction

The Turkish Republic was founded on 29 October 1923 on six main principles. These principles are:

1. “Republicanism”, which sets the ground for democracy.
2. “Nationalism” as a way to unite everyone by citizenship to the Turkish state.

3. "Populism" prioritizing national sovereignty, welfare, and equality.
4. "Secularism", which sets the order and rules in state and educational organizations based on reason and science
5. "Etatism", which gives responsibility to the state to develop its individuals, take care of their education and health, and protect the freedom and security of the country.
6. "Reformism" adopting a contemporary and innovative understanding in organizing institutions.

These principles underline the importance of modernity, i.e., civilization in state, intellectual, and economic arena, as Atatürk defines. Higher education institutions (HEIs), with all their human resources including students, are the flagships of civilization and developmental centers that guide societies with knowledge production and dissemination. Hence, the real meaning of civilization requires the welfare state to take care of its human capital and provide them with the best opportunities possible so that they can compete in the international arena with their counterparts for the good of their nation as the Turkish Republic.

In all societies around the world, the demand for qualified human capital necessitates increasing the education level of populations. This increase typically leads to an expansion in the supply and demand for Higher Education (HE). As a result, some individuals wanting to attain better educational opportunities have to leave their hometowns and countries and move to the city of the HEI they will get their education in. In regions where this expansion is not planned thoroughly, there arises the accommodation problem. In the case of Türkiye, during the last ten years, the number of (formal) HE undergraduate students almost doubled; increasing from 1,351.283 registered students in 2013-14 (Council of Higher Education [CoHE], 2014) to 2,221.498 in 2022-23, which reached to 6,950.142 with vocational schools, distance, secondary and open education, and master's and doctorate students (CoHE, 2023). Based on Eğitim-Bir-Sen (2022, p. 130)'s report, the number of students per dormitory increased from 345 in 2012-13 to 776 in 2021-22. Concurrently, the number of dormitories increased from 882 to 979 during the same period. However, even this was not capable of solving the accommodation problem of students due to a lower rate of supply across the demand for HE. Plus, despite increasing investment allowances and number of dormitories allocated for HE, annual average expenditure per student in tertiary education in Türkiye remained around 10.52$ in 2016 compared with 15.56$ of the Organization for Economic Cooperation and Development (OECD) - average (OECD, 2019). This number did not change

much in 2022 but went even below with 9455$ in Türkiye, being among the lowest among OECD countries, compared to the 17.559$ OECD average (OECD, 2022, p. 5). The same report also indicates the share of research and development (R&D) in tertiary education being 19% in Türkiye and 29% on average across OECD countries. These measures are important as they show the value given to education as a share allocated from the state budget.

With the rapid increase in higher education (HE) in Türkiye—specifically, a growth rate of 31% (from 9% in 2000 to 40% in 2021) in educational attainment among 25-34-year-olds, surpassing the OECD average of 21% (OECD, 2022, p. 2)—there is an urgent need to enhance the capacity of the HE Credit and Hostels Institution (Yurt-Kur). This institution stands out as the most economical and safe residence option for students. The other options of staying in private dorms or rentals have become quite costly, especially in the recent years, with increasing prices in all expenditures that have not grown in parallel with individuals' incomes. In addition, in the 11th Development Plan of Türkiye (Presidency of Strategy and Budget, 2019), "competitive production and efficiency" (e.g., human capital, R&D, and innovation), "quality human capital and a strong society" (e.g., education, health and youth), "habitable cities and sustainable environment" (e.g., housing and regional development), and "state of law, democratization and good governance" (e.g., civil society and security services) had also been noted among the requirements for the development of the country. The realization of these goals partially depends on the provision of the youth of the country with suitable educational opportunities and living conditions. These include safe and affordable accommodation of students that is aligned with their way of living, close enough to their institutions, contain social and sports facilities as well as proper nutrition alternatives and study areas. Accessibility to these opportunities can enable their academic, social and personal development and make them of use to their society once they graduate.

The issue of accommodation of HE students in Türkiye today relate to specific factors. One of these factors is the sensitivity towards "crowding" in the residential area that is affected by social and physical factors (Arlı, 2013; Kara, 2009) as well as cultural differences (Kaya & Weber, 2003). Another issue has been stated as "the difficulties of living away from their families" in terms of money and house management, relationships with people, insufficient nutrition, not getting academic support from familial members, and not having suitable study spaces in dorms (Arlı, 2013). Other concerns have been reported as "inadequate capacity of dormitories" (Eşidir, 2017; Kiraz, 2014), "increasing costs in housing" (Alagöz, 2023; Aydın, 2023; Kara et al., 2019; Öztürk, 2019), "architectural and managerial problems

in dormitories" (Aslanargun, 2014; İnceoğlu, 1995; Tanış, 2023), and issues such as "dorms being turned into quarantine places during the COVID-19 period", students having had to" pay their rents and not having adequate technological equipment" in their houses during this period (Gezer et al., 2022).

Within the scope of this background, this study aims to explore the most critical issues lying behind the accommodation problem of HE students who study in HEIs that are not in their hometowns in Türkiye. Along this line, the research questions are as follows: 1. *What are the main factors lying behind the accommodation problem of Turkish university students in Türkiye today?* 2. *What are the solutions for the accommodation problem of Turkish university students in Türkiye?*

In commemoration of the centenary of the Turkish Republic, the literature review section starts with the historical developments following the proclamation of the Republic in 1923 to the first dormitories built in 1950, the changing roles of the HE Credit and Hostels Institution from its establishment till our time, and the accommodation problem being brought to discussion in the Development Plans starting from 1963 to 2019. The next section makes some international comparisons about the accommodation problem and how different countries approach the issue. Then, the Methods part explains the steps of using a systematic review in the article. Next, the Findings were presented under some sub-titles formed scanning the literature. In the Discussion section, a critical eye has been cast on the topic of accommodation from the perspective of neoliberalism. The Conclusion part summarizes the findings of the study and states its significance. The article concludes with the author's suggestions for addressing the accommodation problem of the university students in Türkiye.

Literature Review

From the Past to the Present: The First University in Türkiye, Higher Education Credit and Hostels Institution and Accommodation Policies in the Development Plans

After the Republic's proclamation in 1923, Türkiye undertook important initiatives, including the removal of Darülfünun as the Ottoman University in 1933 and the establishment of the first university, Istanbul University. Therefore, the first student dormitories in Türkiye can be regarded as the ones that belonged to Istanbul University. With the University Law that passed in 1946, universities were given general autonomy and regarded as legal entities. Subsequent regulations were introduced in 1961, 1971, and 1973, shaping the scope of their rights and responsibilities. These regulations reached their final form in 1981 with the

enactment of the HE Law and the establishment of the CoHE. The initial student housing facilities in Türkiye were brought under the jurisdiction and oversight of the Ministry of Education in 1949 through the implementation of Law No. 5375. Following this, the introduction of Law No. 5661 in 1950 extended permission to both private and non-private entities to establish dormitories, contingent upon inspection by the same Ministry (General Directorate of Credit and Hostels, n.d.). Despite the construction of private entities, motivated by neo-liberal influences to address the housing requirements of students, their accessibility is limited due to financial constraints.

Established in 1961, the HE Credit and Hostels Institution operates under the Constitutional provision that the state provides scholarships and necessary support for successful but economically deprived students to pursue the highest education degree. In 2018, the institution underwent a name change to HE Credit and Hostel Services. Governed by Law No. 351, this institution has been providing learning credits since 1962, supplementary credits since 1985, and scholarships since 2004 (General Directorate of Credit and Hostels, n.d.). In this capacity, the institution remains a crucial center for supporting students in terms of accommodation and finance.

Even though education policies have constituted an important place within the Development Plans, the accommodation problem has taken place only in some of the plans. In the recent years, rather than the problem taking place in Development Plans, it has been evaluated in yearly plans prepared to serve the implementation of the former. Namely, as the whole educational system was thought as the means to educate the human resources necessary for economic development, the 1st Five Year Development Plan (FYDP) (Presidency of Strategy and Budget, 1963) was evaluated together with research and employment sectors. In the 2nd FYDP (Presidency of Strategy and Budget, 1968), it was put forth that HE was something that the most skillful students could get by. However, it was also added that sufficient opportunities for scholarships and boarding could not be provided for those students despite having private dorms. In the 3rd FYDP (Presidency of Strategy and Budget, 1973), the start of open university and associate degree program implementations were mentioned along with not being able to attain the previous aims of increasing the opportunities for credits, scholarships, and boarding. Hence, these aims were taken into the agenda again. In the 4th FYDP (Presidency of Strategy and Budget, 1979), for the first time, it was mentioned under the section Youth Problems that one of the most important problems of the youth in HE was accommodation, which, as a service, was given by various state organizations and private

institutions, with significant difference in the amount of cost demanded. Hence, it was planned to increase the number and capacity of dorms. In the 5th FYDP (Presidency of Strategy and Budget, 1985), accommodation was evaluated among other policies such as health and nutrition but not as a separate goal. In the 6th FYDP (Presidency of Strategy and Budget, 1990), education was determined as the priority sector where it was targeted to give priority to the skillful but limited-income students in the provision of free boarding schools and scholarships, and to increase the capacity of state dorms. In the 7th FYDP (Presidency of Strategy and Budget, 1996), regarding equality of opportunity, low-income students would be financially supported together with the help of the private sector, with no specific reference to accommodation. The 8th FYDP (Presidency of Strategy and Budget, 2001), not specifying the housing issue for students, highlighted the centralized structure of the HE system, clarified the decision-making mechanisms for the new universities that would be built and some other structural problems. In the 9th FYDP (Presidency of Strategy and Budget, 2007), improving the effectiveness of the education system and the efficient use of educational resources were underlined without mentioning student housing. In the 10th FYDP (Presidency of Strategy and Budget, 2014), it was aimed to attain a competitive HE system with qualified human capital and a powerful society. Aligned with this goal, during the preparation period of the plan, the number of universities was increased from 93 to 170 in 2013 May, together with the quotas and enrollment rates. Although direct reference to accommodation problem was not made in this plan, with the increasing university and student numbers, the need for more dormitories was quite apparent. Finally, in the 11th FYDP (Presidency of Strategy and Budget, 2019), there was no direct reference to the betterment of accommodation opportunities for Turkish students but international students (p. 131). In the Education part (pp. 126-127), it was stated that educational buildings would have to be designed in alignment with the technological and environmental developments considering safety, affordability, aesthetics, high standards, quality, and infrastructure.

Briefly, the Development Plans until the 8th, approached the student accommodation problem from the perspective of equality of opportunity. That was prioritized for low-income but skillful and successful students. However, with the mass expansion in HE, access to HE and accommodation has become the problem of all students rather than the low-income only and waiting to be resolved.

Comparison of University Students' Accommodation Problem in Türkiye and Abroad Towards Finding Ways for Solution

In countries like the United States of America (USA), Germany and Australia, which are economically developed, students spare almost similar amounts of budget residing in university dormitories compared with houses in the city; however, students abroad may still prefer to reside in dorms due to the facilities offered in the campus and the higher quality of accommodation in dorms compared with those in Türkiye (Eşidir, 2017). Below can be found some statistics regarding student accommodation in the international context compared with those in Türkiye.

Table 1 International Comparisons of Student Accommodation (Eşidir, 2017; Savills, 2015)

	United Kingdom	Germany	France	Spain	Holland	USA	Australia	Türkiye
Enrolled HE student numbers	2,3	2,7	2,4	1,5	0,7	20,6	1,3	3,2
International student numbers (%)	388	301	295	75	87	886	348	40,5
International students	17	11	12	5	13	4	24	1
Bed capacity (thousand)	524	259	375	90	100	2400	90	810
National provision rate (%)	23	10	15	6	15	12	7	25

As can be viewed from Table 1, compared to other countries, Türkiye seems to provide a higher amount of accommodation including bed capacity. However, considering the increasing demand for HE throughout the years in Türkiye, the rates indicated for Türkiye are not high. Namely, students with (very) serious financial difficulties are comparatively high (30%) in Türkiye, also in Georgia, Iceland and Malta, as opposed to lower rates (19%) in others like Germany, Croatia, France and Sweden (Eurostudent 7, 2021). This differing rate among the stated countries is also related to the varying rates in purchasing power.

When Turkish university students' accommodation problem is compared with that of other countries, although in the USA and in England, student housing sector can be regarded as to have reached a point of saturation, especially in many big cities in Europe, the sector is still open to development with the private sector having a bigger say in owning and managing student houses (Savills, 2015), as opposed to the state control through HE Credit and Hostels Institution in Türkiye. Eşidir (2017, p.18) stated that it is a good option to invest in student houses in Europe by the private sector as it brings steady income and is affected less by financial fluctuations compared with investing in other real estate properties. He added that solution to the issue of university student accommodation is found by universities themselves

that inform students about their accommodation options through their websites and that accommodation problem is not something the state develops policies for but the universities.

Eurostudent 7 (2021), published a report reflecting student social and economic situation in 25 European countries including Türkiye for the 2018-21 period. Accordingly, students preferred the following accommodation options respectively, living with their parents or apart from their parents, alone, with their children and partners or other students in dormitories or in houses. In some countries like Ireland, Poland, France, Hungary, The Czech Republic and Germany, compared with other forms of housing, living with parents still constituted the highest proportion among others. This proportion decreased as the age of students increased. Then comes living with a partner or children, as was chosen by a quarter of students in Iceland, Lithuania, Austria, Estonia, Sweden, Norway and Finland. Students who chose to reside in a student accommodation with friends and other students constituted 17% across countries, which also decreased by age. In Türkiye, Netherlands and Sweden minimum 30% of students resided this way. In all countries included in the study, only 11% lived on their own. The above statistics for Türkiye coincides with that of Özer and Kurtaran (2009)'s, which was conducted with 425 students at İstanbul Bilgi University Youth Studies Center. The results indicated that the main expense in the budget of students was related to housing with 36,4%, This may explain why 30% of students preferred to stay with friends in the previous study, as an indication of this being a less costly option.

The study of Uğur (2020), which compared the living conditions of university students during 2010-2011 and 2019-2020, students preferred to live in student homes in both periods. The reason of this preference may be cost sharing among students who lived together in the same house, as student incomes in Türkiye are below the European average, indicted by Eurostudent 7 (2021). Based on the given data, across all countries, the median income of students is 861 purchasing power standard per month. Except for the countries of Switzerland, Estonia, Iceland, Norway, the Netherlands, Lithuania, Austria, Finland, Croatia, Malta, and Romania, which are above the international median, student income is below the international median in the rest of the countries including Türkiye.

Methods

This study, being a systematic review article, traced certain steps in data collection, the decision-making process regarding inclusion and exclusion criteria, and data analysis (Çınar, 2021). A systematic review has been described as a kind of scientific study that can powerfully put forth proofs by scanning the related topic based on detailed and objective

criteria and using the pre-determined inclusion and exclusion measures to evaluate the studies and research that have been conducted (Hatipoğlu, 2021). In addition, the reliability of the study has been maintained through certain criteria that are explained below.

To begin with, the main research problem was determined as the accommodation problem of university students in the 21st century. Then, two specific research questions were formed that queried the main factors lying behind the accommodation problem of Turkish university students in Türkiye today, and the solutions for the accommodation problem.

Next, the inclusion criteria were decided as the state sources and statistics that dated back to the proclamation of the Turkish Republic in 1923 as well as the expansion of the Turkish HES during the last decade (2013-23 period). The search sentence was determined as "accommodation/housing problem/issue of university students (in Türkiye)". With this regard, Turkish data were compared with those of the OECD countries, of which Türkiye is a part. To detect the recent problems pertaining to the university students' housing, the last five-year data were sought and cited more. However, as this study is also a historical analysis, at times historical comparisons of about twenty-year period were also cited to show the extent of improvement in the topic being sought. Peer-reviewed national and international journal articles and books that covered the given period and topic were included. In terms of choosing among the media sources such as newspaper reports or other online media sources such as the related websites, attention was paid not to cite biased information but facts that could be proved with the specific dates and notes about the given news. Although this study includes a historical analysis of the accommodation problem, that historical part was used only to indicate the developments that have taken place since those times. In other words, the present accommodation problem of university students was the main focus of analysis, which was compared and contrasted with the past decisions and directives that affected the course of the developments. Hence, overly outdated sources that explained the accommodation problem of university students in Türkiye or the accommodation problem in general in Türkiye, which includes the whole society, were excluded from the study.

The collected data were subjected to the document analysis method, which is described as a technique to collect data towards a certain aim by finding and reading resources, taking notes about, and eventually evaluating them (Karasar, 2016, p. 230). To ensure reliability, Ravitch and Carl (2019) provide some criteria, the first of which is "credibility." Credibility was ensured by collecting data from various sources such as state sources and statistics,

researcher studies published in reliable peer-reviewed journals, as well as books and newspaper reports and other online sources. The second criterion, "transferability," was maintained by giving satisfactory contextual information and framework so that future researchers may find it easy to make connections with the topic. The third criterion, "dependability," was facilitated by choosing the method of the study as a review since it allowed for a historical analysis to be made about the topic aligned with the research questions. Finally, "confirmability" was ensured by conducting objective analyses using the cited sources, from which another researcher could derive similar results.

Findings

This section aims to answer the research questions of the study under five sub-topics. To this end, the first research question is "*What are the main factors lying behind the accommodation problem of Turkish university students in Türkiye today*?". The second research question is *"What are the solutions for the accommodation problem of Turkish university students in Türkiye?"*

Present Problems about Accommodation of Higher Education Students in Türkiye

The increasing demand for HE worldwide has shown itself in Türkiye as well. From the establishment of Istanbul University in 1933 until 1980, a steady growth has been observed in the number of the universities that reached to 19. In 1992, 24 more universities were established, marking a turning point in the growth of university numbers (Günay & Günay, 2011). Therefore, one can discuss a considerable expansion in Turkish higher education, reaching 208 universities in 2023 (CoHE, 2022). The expansion in HE in Türkiye brought with it the issue of accommodation, which has been more dominantly observed in larger cities. In this study, this issue is examined in three areas: the cost of accommodation, the capacity of dormitories as well as architectural problems in dormitories and their management.

Inadequate Capacity of Dormitories

Although the problem of accommodation capacity in dorms has increased in recent years, it has been an issue for many years and was discussed in the Turkish Grand National Assembly (2011) 4th union as well. During this session, parliamentarians Aylin Nazlıaka (p. 159) and Candan Yüceer (p. 176) proposed written parliamentary questions regarding dormitory problems of university students. The then parliamentarian Kamer Genç (Turkish Grand National Assembly, 2011) highlighted the dormitory problem of university students as:

> *Although thousands of dormitories are empty today, tens of thousands of university students have been left on the streets…. Many people call us every day; they freeze their university registration as they cannot find a bed in dormitories…. I hope our parliament can find a solution to this problem* (p. 194).

As indicated by the Eğitim-Sen Report (Körfez Gazete Haber, 2022), while there were 191 state dormitories in 2002, this number reached 773 in 2020, not increasing in parallel with the rising number of students. The same source adds that during the same period, the number of private dorms doubled, reaching from 2,210 to 4,406, comprising associations (2,894), foundation dorms (416), personal dorms (368), commercial dorms (666), and university dorms. When the number of students per state dormitory was 345 in the 2012-13 academic year, this figure increased to 776 by the 2021-22 period (Yurdakul & Şahin-Demir, 2022) (Figure 1).

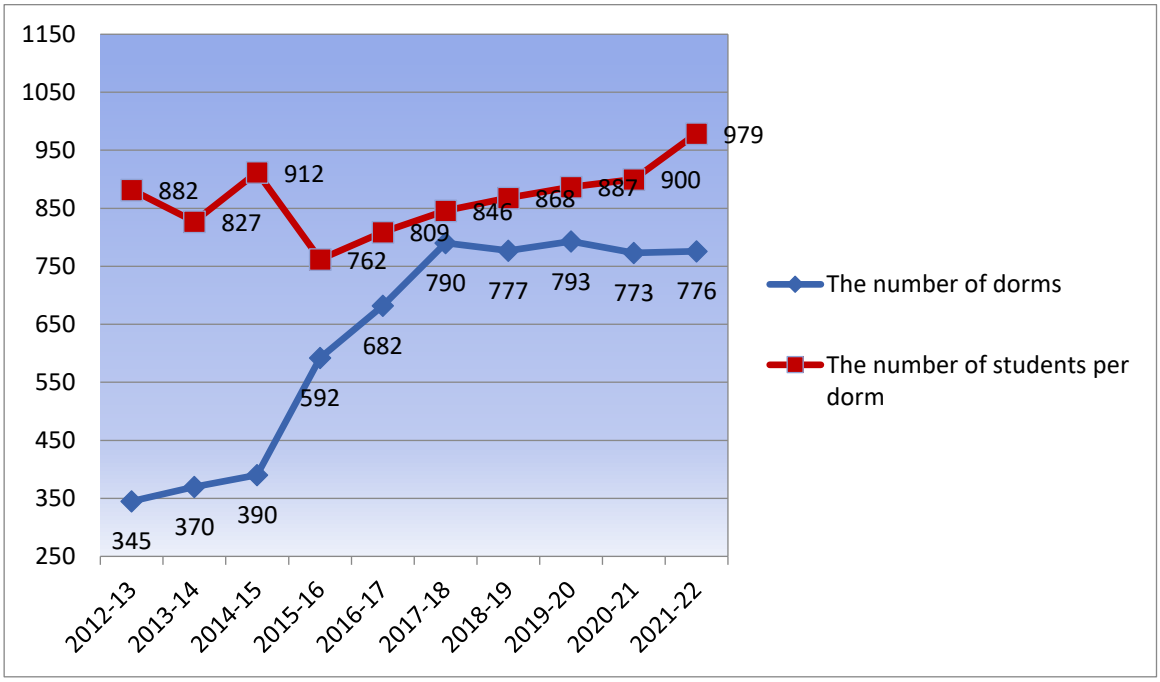
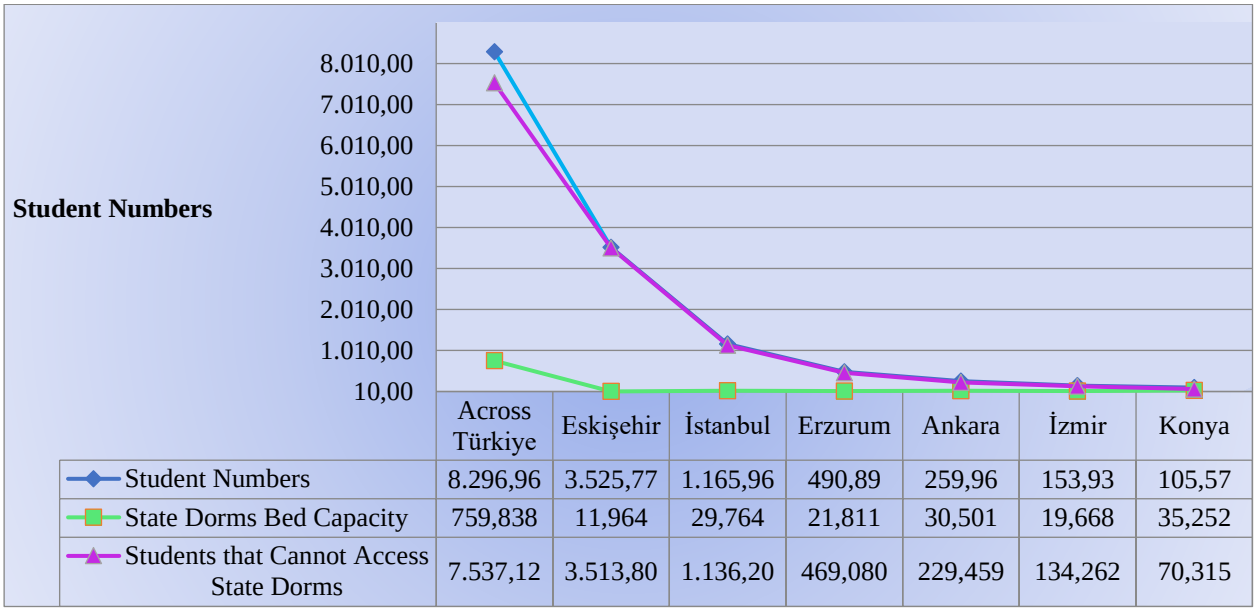


Figure 1 The changes in dorm capacities from 2012-13 to 2021-22 Academic Year (Yurdakul & Şahin-Demir, 2022)

The HES in Türkiye has undergone significant expansion over the years. Having a Higher Education Institution (HEI) in every city, when all components of the HES are planned accordingly, would naturally bring about an equivalent level of quality and meet the needs of students. However, this expansion neither contributed to academic quality and

efficiency in the HES (Armağan, 2014; Ministry of National Education [MoNE], 2019) nor enabled an adequate capacity for state dormitory beds (Figure 2).



	Across Türkiye	Eskişehir	İstanbul	Erzurum	Ankara	İzmir	Konya
Student Numbers	8.296,96	3.525,77	1.165,96	490,89	259,96	153,93	105,57
State Dorms Bed Capacity	759,838	11,964	29,764	21,811	30,501	19,668	35,252
Students that Cannot Access State Dorms	7.537,12	3.513,80	1.136,20	469,080	229,459	134,262	70,315

Figure 2 The Number of Students in Higher Education vs. The Bed Capacity in State Dormitories (2021-22) (MoNE, 2022; Data Source, 2022)

As Figure 2 suggests, in the 2021-22 academic year, the number of dormitories increased to 776 with 759,838 beds as of June (MoNE, 2022). During the same period, Eskişehir had the highest student population with 3,525,767, but only 11,964 beds were allocated in state dormitories (MoNE, 2022; Veri Kaynağı, 2022). This was followed by İstanbul, Erzurum, Ankara, İzmir, and Konya. Although more than half of the students studied in Eskişehir, İstanbul, and Erzurum, bed capacities were among the lowest compared to student numbers. Accordingly, 90.84% of students across Türkiye, 99.66% in Eskişehir, 97.45% in Erzurum, 88.27% in Ankara, 87.22% in İzmir, and 66.61% in Konya could not access state dormitories in the 2021-22 academic year. This serves as a recent proof of the unplanned expansion in the Turkish HE system that associates expansion only with new university openings, irrespective of investing in the necessary infrastructure, including student accommodation.

Turning to the current scenario, in the academic year 2022-2023, over half of university students have chosen to reside in the Anatolian (2,731,121) and Marmara (1,915,782) regions (CoHE, 2023). The Minister of Youth and Sports, Osman Aşkın Bak, announced plans for the 2023-24 academic year, stating that the HE Credit and Hostels Institution dormitories will

offer services with a capacity of 950,000 beds. The aim is to place students in the nearest dormitory possible, with a priority focus on those affected by the February 2023 earthquake (Sarıgöl Gündem, 2023). However, given the current student enrollment of 6,950,142 (CoHE, 2023), the state's provision of 950,000 dormitory beds falls short, covering only about 13.6% of the demand. Private dorms may not be financially accessible to many students, may not meet nutritional standards, and could be located far from campus. Consequently, a significant number of students opt for university and state dorms, offering time and cost savings, but unfortunately, these options are still insufficient in number. Thus, there is a pressing need to expand dormitory bed capacities in cities with a high density of students.

One of the challenges is the limited time that elapses between the announcement of YKS exam results and students securing accommodation before the start of the fall term, which has consistently been a brief period. For example, in the 2023-24 academic year, exam results were announced on August 19, 2023, and classes are scheduled to commence around the end of August or early September. Consequently, students are left with only about 10-15 days to find a place to live. Applications for state dorms began on August 29, 2023, and will conclude on September 2, 2023, lasting for only a 4-day period. This implies that by the time students learn the results of their dormitory applications, it may already be too late as their classes would have started. This excessively limited timeframe does not facilitate students in finding suitable accommodation. There is a need for reconsideration of the timing of university exams and their announcements.

Cost of Accommodation

Beyond the geographical aspect of accommodation, financial concerns loom large for both students and their parents. On June 7, 2022, Turkish parliamentarian Ali Haydar Hakverdi submitted a written inquiry to the Ministry of Youth and Sports, delving into the accommodation challenges faced by university students (Hakverdi, 2022). The inquiry briefly outlined the predicament of students who, during the 2021-22 academic year, found themselves compelled to seek lodging away from their families. Their preference was state dorms, and failing that, they resorted to private dorms or high-rent houses, putting a strain on their budgets. Hakverdi underscored the fact that lower-income students often had to interrupt their education even before it began. Urgent measures were urged to prevent the recurrence of these challenges.

Coming to 2023 fall semester, more than 898.000 students will start HE in Türkiye for the first time soon, filling 923,411 seats and making the capacity full at 99,8%, excluding over-34 women, earthquake survivors, and relatives of martyrs and war veterans (VOA, 2023). To start with a preferred accommodation for students due to its comparable affordability, HE Credit and Hostels Institution's (state) dorm prices, excluding the ones in Northern Cyprus, ranged from 275-450 ₺ in 2021-22, 500-800 ₺ in 2022-23, which will be around 345-570 ₺ in 2023-24, plus 855-1365 ₺ deposit (Başarı Sıralamaları, n.d.). Private dorms, on the other hand, with around 85-105% increase in prices compared to the previous year, charge annually 20.000-320.000 ₺ as of July 2023, indicating the average of 21 cities (Alagöz, 2023). As for the rentals, according to the data of an online real estate analysis platform, endeksa.com, they showed a 152% increase in 2021, and 233% increase since 2019 (Yurttan Sesler, 2022). The same platform states that as of June 2023, average rents in Muğla increased by 73% and reached 14,937 ₺; in Antalya by 310% with 10,397 ₺, and in İstanbul by 16% amounting to 8,107 ₺. İstanbul is currently the most expensive city in Türkiye (Aydın, 2023). According to Bahçeşehir University Economic and Societal Research Center (BETAM)'s Outlook of Rental Housing Market, average annual increase rate in rents in Istanbul was 109.5% in June 2023, with average rental house square meter price being 161 ₺ (Sözcü, 2023). In Istanbul, one has to pay from around 15.000- 60.000 ₺ for a 2+1, 30-40-year-old apartment building as of the summer of 2023 (Hepsiemlak, 2023).

İskan Aydeniz, an education coach residing in Diyarbakır, highlighted a significant concern regarding the rising costs in the country (Tanış, 2023). According to Aydeniz, this is the first time since 2003 that he has observed parents expressing such worry about sending their children to big cities:

> *The problem is not only foundation (non-profit private) universities losing their appeal but the opinions of parents whose children have been ranked in the top 5-7000 in the university entrance examination. They are worried; they ask: 'How are we going to afford to look after them by letting them go to big cities?'. For instance, the parent of a student who wants to study medicine with 7000th rank says on behalf of the child: 'I don't want to send him to Istanbul, Ankara or İzmir but want him to stay in Dicle and study here.*'

The President of Parent Association, Ömer Yılmaz said the economic crises affected students' basic needs radically. He added that as their accommodation and nutrition needs are not met, last year around 110.000 students could not get enrolled to their university even

though they had been successful in the entrance examination (Tanış, 2023). Therefore, he underlined the need for the provision of accommodation first, and then, nutrition needs of students immediately.

The Vice President of the Republican People's Party, Ahmet Akın pointed out the difficulty for a university student to pay the rents and high dormitory costs. He informed that as a panacea, some of their municipalities will provide students with accommodation in suitable sites. These will be public housing or youth hostels. Students will also be getting financial aid from volunteering companies and individuals with the mediation of their municipality in this 2023-24 academic year (Evrensel, 2023).

Given the increases in all kinds of accommodation, the purchasing power and the rising inflation rates have not suggested desirable trends. Specifically, based on the Confederation of Turkish Trade Unions (Türk-İş), poverty threshold in July 2023 rose to 37,974 ₺ and hunger threshold (a four-member family starvation limit) to 11,658 ₺, exceeding the minimum wage of 11,402 ₺ (Duvar English, 2023). For 2021, the inflation rate was suggested as 82.81% annually by the independent Inflation Research Group, ENAGroup (ENAG, 2022), which rose to 128.05% as of August 2023 (ENAG, 2023). The above explained disproportion between rising accommodation costs, inflation rates and diminishing income power highlight the belated call made to the state authorities to do their best to accommodate all university students with a reasonable cost and in the shortest time possible so that they can continue with their education under humane conditions.

Architectural and Managerial Issues in Dormitories

Another issue in dormitories has been identified to stem from their architecture. According to Akpınar (2014), this problem is rooted in the lack of a homely atmosphere, with a disregard for the spiritual and social aspects of human beings. Specifically, 64% of students expressed a preference to stay alone or with another student in a room, but not with more than eight students in total. Additionally, most students preferred to study in their own rooms rather than a common study area. Students were dissatisfied with not being able to invite guests to their rooms, along with concerns about tall dormitory buildings, overcrowded floors, and rooms lacking essential facilities such as a shower and a toilet (İnceoğlu, 1995). Arlı (2013) also highlighted the inadequacy of study spaces in a study conducted among students.

Residential students have reported another set of issues in both private and state dormitories, primarily related to dorm management. These encompass a range of concerns,

from undesirable hygiene conditions in food preparation areas to the uncleanliness of shared spaces such as bathrooms, toilets, cafeterias, and study rooms. Issues also extend to entry-exit hours, crowded spaces, and difficulties in personal relationships with roommates (Aslanargun, 2014; İkiz, 2008). Unhealthy nutrition emerged as a particular concern in the dormitory environment (Arlı, 2013). Additional problems include the absence of hot water, power outlets, or earthquake-resistant architecture in old state dorms, along with incidents of theft (Ekşisözlük, 2006). Some students have likened state dorms to prisons, expressing discontent with the insufficient availability of dorms and beds, a sentiment echoed in writings from 2017 and 2018 (Ekşisözlük, 2017).

Suggestions for Solution

This section aims to answer the second research question of "What are the solutions for the accommodation problem of Turkish university students in Türkiye?" Building upon the sources discussed in the preceding sections that highlight the various facets of the accommodation problem, this section puts forth suggestions for solutions and policies based on an extensive review of literature sources.

A circular letter addressing "Security and Housing Precautions at Universities" had been sent to municipalities (NTV, 2022). In response to the high cost of accommodation for students, the circular proposed measures to prevent extreme increases in rentals and dormitories. Moreover, low-income students were slated to receive support through scholarships and accommodation facilitated by non-governmental organizations and state institutions. To address the issue of inadequate capacity in dormitories, the circular highlighted plans to conduct needs analyses related to students' cities and counties, with a commitment to subsequently increase capacity. Arslan (2021) further suggests that for students studying in suburban university campuses who do not prefer dormitory accommodation, tiny houses can be considered as an alternative due to their easy manageability and suitability for a single person. However, the affordability of tiny houses for students remains uncertain.

In relation to the architectural and managerial challenges within dormitories, a study conducted by Kara et al. (2019) unveiled that 45.3% of students expressed a sense of solitude in state dorms, while 30.1% reported a similar feeling in private dormitories. The authors suggested that this might be correlated with the restricted choices available to students in state dorms when selecting roommates and determining the number of students per room. They underscored the potential psychological risks arising from feelings of isolation and health

concerns. Despite these issues, the authors concluded that the sole advantage of state dorms lies in their financial affordability. To address these challenges, they proposed the early allocation of a counselor instructor to students upon university registration, with additional support from the social services center. Furthermore, the authors advocated for the idea of initially placing students with similar characteristics, determined through tests administered by the Credit and Hostels Institution (i.e., being from the same city and department), in shared rooms to facilitate their adjustment to university life. They also recommended the design of dormitories resembling houses to foster a more comforting atmosphere for students.

Discussion

This review study investigated the fundamental challenges surrounding the accommodation problem for university students in Türkiye, spanning historical developments to the present day. It also explored the proposed solutions documented in the literature. Furthermore, the article concludes with recommendations formulated by the author.

Commemorating the centenary of the Turkish Republic in October 2023, it remains lamentable that the issue of housing for university students persists. Despite the constitutional assurance of the fundamental right to housing, the state has grappled with meeting the escalating housing demands of students, particularly in the context of the expanding higher education sector in Türkiye over the past two decades. A case in point is elucidated by Kiraz (2014) in his study, where, in Tokat, the availability of state dormitories with a capacity of 3000-5000 proved insufficient for the accommodation needs of the 20 thousand students. Consequently, those unable to secure a spot in state dormitories were compelled to seek housing in private residences, thereby imposing financial burdens on them.

According to Öztürk (2019), the planning of cities under the umbrella of overconsumption has led to a distinct positioning of universities. The concept of "one university in every city," viewed as one of the neoliberal policies aimed at urban development (Erilli, 2018), is perpetuated through the prioritization of spatial consumption over student welfare. The framework of neoliberal urbanity has provided an avenue to channel products created for capital disposal (Harvey, 2016) through students, who become instrumental in the credit mechanisms integral to the consumption system. With contemporary production centers concentrating in Far Eastern cities, the Western cities, traditionally synonymous with production hubs, have witnessed a dilution of this characteristic. Consequently, this shift has

relinquished primary housing rights in university cities to the purview of private capital, aligning with neoliberal policies (Kazgan, 2009).

The standard of student housing plays a pivotal role in influencing their academic success and social and personal development (Arlı, 2013). Therefore, the state's crucial role in providing essential housing opportunities cannot be overstated. Such initiatives would particularly benefit middle-income families, potentially motivating them to support and facilitate their children's education in cities beyond their residence.

Conclusions

This study sought to scrutinize the growing accommodation challenges encountered by higher education students. Employing document analysis as the principal method, a range of sources, including state statistics from websites, peer-reviewed journal articles, newspaper reports, and national and international reports, were consulted. The investigation spans from the inception of the Turkish Republic to the present day. The culmination of this analysis has resulted in the formulation of specific suggestions to address the identified issues.

The primary and frequently noted concern regarding the accommodation of higher education students revolves around the insufficient availability of state dormitory beds compared to the growing demand in higher education. This challenge has persisted since the establishment of the first university, Istanbul University, in 1933. The second concern centers around the surging cost of accommodation, driven by the general uptick in various expenses over recent years in Türkiye. This issue has been further compounded by the adverse effects of the Covid-19 pandemic, casting a negative impact globally. The third identified problem stems from architectural inadequacies in dormitories, demanding reconstruction or reorganization to cultivate a homelier environment that caters to students' physical needs during their residency. Lastly, managerial shortcomings have impacted the quality of stay in dormitories, including constraints on entry-exit times, hygiene issues in common areas and food services, and the need for regulation of behavioral problems among students.

As we approach the centenary of the Turkish Republic, set to be celebrated on October 29, 2023, the recognition of the significance of human capital alongside physical capital has been aptly acknowledged by our state, as articulated in recent Development Plans. This understanding has translated into a significant expansion within the Turkish higher education system. This expansion underscores the heightened role of higher education in shaping qualified human capital, fostering critical consciousness in economic expansion, contributing

to democratization, and disseminating cultural values to society and future generations. As the realm of higher education undergoes significant expansion, the demand for accommodation has concurrently surged, driven by students parting ways with their families to reside in cities where their universities are located. A majority of these students find themselves compelled to opt for university or state dormitories, influenced by factors ranging from logistics to financial constraints. In the spirit of Mustafa Kemal Atatürk entrusting the future of the country to its youth, both private and state authorities bear the responsibility to address the pressing issue of student accommodation. In the 21st century, with students needing to compete and collaborate globally using cutting-edge technology, imperative foundational issues such as education, nutrition, and accommodation must be promptly resolved. Additionally, it is imperative to chart new objectives that can position Türkiye for a robust and impactful future.

Recommendations

The following are policy suggestions for stakeholders who may serve as policymakers within the higher education (HE) system. These include university presidencies, the Council of Higher Education (CoHE), and other state authorities involved in budget allocation and decisions concerning student accommodation. Private foundations are also encouraged to collaborate with the state in addressing this issue, offering support through funds, human resources, or equipment they can provide.

The most striking issue about the HE accommodation problem in Türkiye has been detected as the “insufficient capacity of the existing state dormitories” and “the high cost of accommodation” in rentals and private dorms. To increase the existing capacity in state dorms, the budget allocated from the Central Management Budget for HE can be increased and a specific policy to limit excessive increases in rents for students can be implemented. In addition, state and private sectors can cooperate to speed up the process of building more dorms. Universities can also get into contact with private sector for financial support as well as provision of accommodation in their own capacity. In this sense, to incentivize investments in the establishment of student houses, the private sector could be offered encouragement and incentives. Additionally, the state and volunteering private sector companies, offering accommodation scholarships to low-income students can be an option. Along with these, if dorms are built in the campus by providing various facilities ranging from sports to music and socializing, students will not be exposed to the traffic every day, save time, energy, and spare more time for studying and being with their friends in a safe area, enjoying the campus

atmosphere. Considering the importance of human capital, also highlighted in the 10th Development Plan, successful students can be given more opportunities for accommodation as they have more potential to be of use to the development of the country.

As for "issues related to the physical spaces in dorms", these challenges can be addressed through architectural adjustments, the use of attractive colors, and furniture designed to resonate with the preferences of the youth. Unused spaces in and around dormitory buildings can be repurposed to create quiet areas, such as self-study rooms, and small to medium-sized halls where students can gather, chat, and share meals, fostering a sense of community. Organizing social activity days, including events like film screenings and dance gatherings, can mitigate feelings of isolation, allowing students to enjoy themselves and form meaningful connections. By implementing such activities and introducing changes to the physical structure, dormitories can be transformed into more inviting spaces where students feel a sense of belonging and create cherished memories that will impact their lives for years to come. Additionally, providing more than one type of dormitory (with costs varying based on the amenities offered) allows students the flexibility to choose accommodations that suit their preferences. Furthermore, it is essential to plan accommodation alternatives specifically tailored to the needs of master's, doctorate, and international students by identifying the areas with the highest demand.

Addressing "dormitory management-related issues," including unclean common areas such as bathrooms and kitchens, unhygienic food services, overly restrictive entry and exit times, and an excessive number of students in dormitories, requires proactive measures by the management offices of individual dorms. Possible actions could involve seeking the opinions of residing students through questionnaires to understand both their satisfaction and dissatisfaction. The crucial aspect lies not merely in conducting these assessments but in earnestly aiming to resolve issues by actively following up on the outcomes of the questionnaires. Lastly, empowering students with more influence over the environments they inhabit is considered instrumental in enhancing overall quality and satisfaction levels.

For academics and prospective researchers interested in exploring the same or similar topics, it is recommended to consider conducting a mixed-method study. This approach can help mitigate the limitations associated with each individual method, providing a more comprehensive understanding. Another suggestion is to undertake a comparative study, examining accommodation issues experienced by students in other countries. Such a comparative analysis could offer insights that may be adapted to enhance our own system.

Ideally, planning a collaborative project involving state institutions, non-governmental organizations, universities, and private sector companies could be an effective strategy for actively addressing and solving housing problems faced by university students.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

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It is a single-author study the processes of which have been carried out by the corresponding author.

Research involving Human Participants and/or Animals

This study, being a review, does not require Ethics Committee Permission.

Geçmişten Türkiye Cumhuriyeti'nin 100. Yılına, Yükseköğretim Öğrencilerinin Barınma Sorunu

Özet:

Türkiye, yükseköğretim sisteminde, özellikle 2000'lerden sonra, kayda değer bir genişleme sürecinden geçmiştir. Ancak bu genişleme, öğrencilerin barınma sorununu da beraberinde getirmiştir. Bu çalışma, eğitim aldıkları şehirlerde yaşamak üzere memleketlerini terk etmek zorunda kalan Türk yükseköğretim öğrencilerinin barınma sorununun incelenmesine odaklanmıştır. Doküman analizi olan yöntem, hakemli dergi ve gazete makalelerini, ulusal ve uluslararası rapor ve istatistikleri ve çeşitli çevrimiçi kaynakları içermektedir. Bunlar, 1923'de Türkiye Cumhuriyeti'nin ilanından, 2023'te Cumhuriyet'in 100. yıl dönümüne kadar olan süreyi kapsamıştır. Temel bulgular kısaca, üniversite ve devlet yurtlarındaki yetersiz yatak kapasitesine, barınma maliyetindeki çarpıcı artışlara ve yurtlardaki servisin kalitesini ve öğrencilerin günlük rutinlerini olumsuz etkileyen yurt mimarisi ve yönetimsel sorunlara işaret etmiştir. Daha kapsamlı bir analiz için, ilerideki araştırmacılara, karma metotla yapacakları bir çalışma önerilmektedir.

Anahtar kelimeler: yükseköğretim öğrencileri, barınma maliyeti, yurt kapasiteleri, yurt yönetimi, Türkiye Cumhuriyeti'nin 100. Yılı

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Research Article

Examining the Role and Perceived Importance of Video Experiments on Pre-Service Science Teachers' Understanding of Faraday's Law in Online Learning Environment

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Abstract–In this study, it was aimed to reveal the effect of teaching designed using real experiment videos on the development of pre-service science teachers' ideas about Faraday's law of induction and to determine the experiments that pre-service science teachers considered most effective in their understanding of the induction phenomenon. The study was conducted online during the pandemic period with a sample of 52 first-year pre-service science teachers. The predict-observe-explain (POE) learning model was used in the teaching process and semi-structured interviews were conducted with nine pre-service science teachers before and after the teaching. The interview data showed that the pre-service science teachers had many scientifically unacceptable ideas about Faraday's law before the instruction, while these ideas were transformed into scientific truths after the designed instruction. In addition, it was tried to determine the experiment or experiments that pre-service science teachers found most effective in understanding the subject after the instruction. Finally, it was concluded that teaching based on the POE learning model supported by real experiment videos used in online teaching was successful in remedying pre-service science teachers' unacceptable notions about electromagnetic induction and various suggestions were made in this regard.

Key words: POE learning model, online learning, Faraday' s law, physics experiments, pre-service science teachers.

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Introduction

Coronavirus, which unexpectedly affected the whole world, was declared as Covid-19 pandemic by the World Health Organization on March 12, 2020 (WHO, 2020). Thus, many

educational institutions worldwide, from preschool to university, have closed their doors (Saavedra, 2020). In most countries, education is provided through distance education platforms (Reimers, 2020). Higher Education Council (HEC) announced all universities to continue education with their distance education resources on the 18th of March, 2020, as in Turkey (YÖK, 2020). Thus, all universities have completed their preparations and switched to distance education in a synchronous or asynchronous manner.

Today, distance education is often associated with the Internet. In fact, much earlier, teaching activities were carried out via radio, mail, or TV (Moore & Kearsley, 2012; Sumner, 2010), and distance education was also used to describe a form of education that is carried out via radio, letter, mail, or TV. Over time, both the definition and the way of application of distance education, which has turned into an online learning environment thanks to developments in technology, have changed (Siemens et al., 2015). Digital transformation is now associated with Industry 4.0 and widely used in the 21st-century world. Therefore, the use of different systems and tools in education has become mandatory due to the Covid-19 pandemic.

Distance learning has many advantages. First of all, it is quite cheap after the initial investment costs are covered. People can receive education from different parts of the world regardless of time and place. Unlike traditional course materials, students can easily adapt multimedia materials to distance education. They can increase or decrease their study hours according to their learning speed (Şahin, 2021).

It is known that distance education, which has entered our lives compulsorily with the pandemic, also has some limitations. Internet connection problems that may occur during the lesson (Korkmaz & Toraman, 2020; Saltan, 2017); lack of interaction between the students and the educators, difficulty in providing feedback to students (LaRose & Whitten, 2000); difficulty in teaching according to the individual interests and abilities of the students (Nart & Altunışık, 2013); not being able to provide skills teaching, lack of student motivation during online learning (Sintema, 2020) are examples of these limitations. Studies on distance education at different age levels during the pandemic process have reported that similar problems are experienced and for these reasons, participation in the courses is low (Başaran et al., 2020; Karademir et al., 2020; Koçoğlu & Tekdal; 2020; Korkmaz & Toraman, 2020; Şahin, 2021; Ünal & Bulunuz, 2020). As a result of these studies, it was seen that alternative methods and techniques are needed to make online education more efficient and to increase students' interest and motivation. On the other hand, instructors need to have some basic

technology usage skills to provide online education. Therefore, it is necessary to support the lessons with a number of different teaching materials and techniques to ensure classroom control, student motivation, and an interactive learning environment (Winstead, 2021).

The Predict-Observe-Explain (POE) is a learning model that allows students' motivation and interest to be highly utilized and allows the use of a variety of teaching materials. POE was developed by White and Gunstone (1992), and Pegg (2006) defined POE as the most basic inquiry-based model. In the POE model, the steps are as follows: In the first stage, the prediction; students are presented with a situation, scientific problem, or activities. Students are requested to make predictions with their justifications regarding the possible outcome of the concept or event presented. In the second stage, the observe, students make observations about the initial event and learn to infer a cause-effect relationship for the initial event by taking their observations into account. Observations are repeated when necessary. In the final stage, the explanation stage, students are asked to compare their predictions and observations (Kearney, 2004; White & Gunstone, 1992; Yaşar & Baran, 2020). Many studies have proved that the POE model is beneficial for students learning science (Banawi et al., 2019; Choowong & Worapun, 2021; Hong et al., 2014; Hsiao et al., 2017; Nalkıran & Karamustafaoğlu, 2020; Yang & Chen, 2021). This approach is suggested to be implemented to improve students' conceptual understanding by actively confronting the students with their prior knowledge and to encourage knowledge application as well as construction (Chen et al., 2013; Hsu et al., 2011; Rini, et al., 2019; Zhao et al., 2021). On the other hand, studies show that combining the POE learning model with online learning or digital audio and video learning can help students understand concepts (Akpınar, 2014; Chen, 2020; Hsiao et al., 2017; Yang & Chen, 2021).

Since physics topics involve highly abstract concepts, they should be supported by practical work in which students actively participate in the learning process (El Kharki et al., 2021). Practical work is defined as an indispensable feature in science and physics courses (Abrahams & Millar, 2008; Cai et al. 2021; Gott & Duggan, 1996; Wellington, 1998). Yet in spite of the importance attached to the practical work, it has been reported in various studies that the physics courses are mostly based on mathematical equations and lectures on a theoretical basis by ignoring the basic concepts of the students at the university level (Marrongelle, 2004; Mulhall & Gunstone, 2012; Redish & Gupta, 2009). Considering the claim that practical work strongly influences students' understanding of science concepts (Millar, 2010), it is necessary to investigate the effectiveness of a designed teaching model

that is based on the pre-conceptions of the students and includes practical work with teacher demonstrations. It is emphasized that activities that make students active in the lessons, such as experimentation under practical work, will facilitate students' learning and increase their interest and motivation in the lesson (Palmer, 2009). In a similar line of thought, as Chen (2020) reported in his study, it can be argued that the use of teaching approaches that engage students in active learning might increase their interest and motivation towards learning the subject matter in online learning too.

Induction is one of the most difficult abstract topics in physics for students to understand (Guisasola et al., 2004; Maloney et al., 2001; Törnkvist et al., 1993). Studies show that even university students attempt to interpret the formation of induced electromotive force (emf) based on the presence of a magnetic field or based on the direction of the magnetic field lines, without relating it to the flux change (Kocakülah, 1999; Kocakülah, 2002; Loftus, 1996; Thong & Gunstone, 2008; Zuza et al., 2016). Tangible examples and taking note of everyday events that simplify the understanding of induction help to clarify its understanding in students' minds and have a role in motivating students to learn. Examples that can be demonstrated in a classroom environment can be achieved with a couple of mechanisms that can be easily set up. In the classroom environment with different methods of closed circuits, students can be shown that flux change must occur to use Faradays' law $\varepsilon=-N\, d\phi/dt$ and form-induced emf. However, as a result of the transition to distance education with the pandemic, not being able to perform laboratory applications and demonstrations with them, which students will follow with interest and curiosity, appears as a deficiency in their conceptual understanding.

With the introduction of computers into all areas of our lives, the use of virtual laboratory simulations in teaching has increased especially since 2010 (Raman et al., 2022; van Joolingen et al., 2007). There are also studies showing that the use of virtual laboratories has a positive effect on students' conceptual understanding (Lestari & Supahar, 2020; Raman et al., 2022; Taasoobshirazi et al., 2006; Zaturrahmi et al., 2020). However, while there are researchers who advocate the use of virtual laboratories instead of real experiments in students' conceptual understanding (Finkelstein et al., 2005; Klahr et al., 2007), there are also studies showing the benefits of using both applications in a way that supports each other (Anam et al., 2023; Başer & Durmuş, 2010; Brinson, 2015; Jaakkola & Nurmi, 2008; Ronen & Eliahu, 2000; van Joolingen et al., 2007; Zacharia et al., 2008; Zacharia, 2007). On the other hand, Ma and Nickerson (2006) state that the effectiveness of laboratory work depends

on how much students believe in the experiments. Similarly, Kocakülah and Kocakülah (2006) conducted interviews with pre-service teachers about the teaching of electromagnetism using simulations and real experimental setups together. The students stated that simulations were not as convincing as real experiments, learning would not be permanent in a lesson based only on simulations, and simulations could be used for reinforcement at the end of the lesson.

For the above reasons, in this study, it was decided to use real experiment videos prepared by the instructor in distance education in order to be more interactive with the pre-service science teachers and to increase the credibility of the experiments instead of ready-made simulations that can be easily accessed on the internet.

In this study, a teaching model based on a POE has been designed for the pre-service science teachers in an online classroom environment by taking into account the pre-conceptions of the pre-service science teachers and supporting with different real experiment videos. Therefore, this study aims to reveal the impact of designed teaching using different experiment videos on the development of pre-service science teachers' ideas about Faraday's law of induction and to determine the experiments that pre-service science teachers consider the most effective in their understanding of the induction phenomenon.

Method

Research Design

A study with one-group pretest-posttest weak-experimental design (Fraenkel et al., 2012) was conducted in a university introductory physics course to evaluate the effectiveness of the real experiment videos during teaching Faraday's law of induction. The study was conducted during the Covid-19 period and in the 2021-2022 academic year, and there was only one physics class during the study period.

Participants

This study was carried out with 52 first-year pre-service science teachers, attending the faculty of education at a state university in the western part of Turkey, ranging in age from 19 to 21. The faculty where the researcher works was selected for the purposes of the purposive sampling method. The faculty has a good reputation in training and has trained pre-service teachers for over a century.

Data Collection

The data collection tool used in the study to reveal the effectiveness of the instruction was semi-structured interviews. Nine pre-service science teachers who were interviewed in the study were selected on a voluntary basis and among the pre-service science teachers who did not have internet connection problems in the class. Before and after instruction, those nine pre-service science teachers were each online interviewed for between 30 and 45 minutes. Five of the pre-service science teachers were female and four were male. During the interviews, the researcher conducted the experiments online from the laboratory using the experimental setups prepared in advance. The purpose of designing the interviews in a semi-structured way was to be able to ask different questions to the pre-service science teachers by making the desired changes in the experimental setup when necessary and thus to obtain more detailed data. The data obtained from the interviews were transcribed and analyzed descriptively and presented in the findings section in relation to the pre- and post-instruction findings.

In order to determine the experiment that the pre-service science teachers found most effective at the end of the instruction, a questionnaire was used as another data collection tool. At this stage, data were collected through a questionnaire sent via Microsoft Forms. In the questionnaire, the pre-service science teachers were asked to write which experiment or experiments were effective in their understanding of the subject from the experiments used in the course and to write this with the justification. The data obtained were presented by frequency analysis.

Teaching Process

In the university where this study was conducted, Microsoft Teams software is used as a distance education platform. Therefore, all of the lessons and interviews were conducted through this application. In addition, Microsoft Forms application was also used from time to time for the pre-service teachers to respond to the questions asked during the course.

The teaching period lasted 6 course hours (each course hour is 90 minutes) and the devised teaching plan was administered in the 'Physics II: Electricity and Magnetism' course conducted by the researcher.

The teaching process consists of three stages. Before starting to teach the topic, the short life story of Michael Faraday from the documentary entitled Einstein's Big Idea was shown to attract pre-service science teachers' attention and arouse curiosity. Then, a short

discussion was held with the pre-service science teachers on the importance of Faraday's experiments, which both activated the pre-service science teachers' prior knowledge and guided the instructor to determine the pre-service science teachers' level of knowledge. This part was completed in one class hour.

Table1 Experiments used during teaching and their specific objectives

Lesson Number	Experiment Number	Experiment Name	Purpose
Lesson II	1	Deflection of the galvanometer pointer	To demonstrate the formation of the induced emf that is indicated by the deflection of a galvanometer pointer by means of the changing magnetic effect of a bar magnet which is moved towards and away from a coil whose ends are attached to a galvanometer.
	2	A coil connected to the direct current source by a switch	To understand the formation of an induction current with a direct current and to demonstrate that a conductor carrying a current is also the source of a magnetic field.
Lesson III	3	Lighting up a led bulb	To comprehend the formation of the induced current with an alternating current source.
	4	Lighting up a torch bulb	To observe whether an induction current is generated by direct current and alternating current sources.
Lesson IV	5	Jumping aluminum ring	Same purpose as experiment 4.
	6	Split aluminum ring	To discuss the closed path in which the induction current flows.
Lesson V	7	Aluminum pipe experiment	Same purpose as experiment 1.

In the second stage, lessons were taught in accordance with the POE model. In the first phase of the instructional model, the online video demonstration experiments to be carried out were presented to the pre-service science teachers respectively, and they were asked to estimate the outcome of each experiment and explain the reason for their estimation. Pre-service science teachers were asked to write their predictions through Microsoft Forms application. In the second phase, demonstration experiments videos were watched. At this stage, each experiment was repeated several times so that all pre-service science teachers could see the experiment and fully understand the event. In the third phase, pre-service science teachers were asked to compare their predictions and observations for each experiment, and the results were discussed in the class respectively. Table 1 summarizes the experiments carried out in the teaching process. All videos of the experiments used during the teaching process were shot by the instructor and each detail was carefully explained to the pre-service science teachers.

In the third stage of the teaching, a discussion was held in the classroom about the possible applications of electromagnetic induction in daily life. The working principles of tools such as electric generators, transformer systems, electric guitars, and induction furnaces were discussed with the pre-service science teachers. Then, to show the pre-service science teachers how the induction furnace works, the device in Figure 1 was set up in the laboratory by the researcher and the video of the device was recorded and shown to the pre-service science teachers during the lesson. In this way, the pre-service science teachers observed the change in the temperature of the water in the pipe and discussed how Faraday's Law applies to the situation in this setup.

Figure 1 The experimental set-up for induction cooker

Introducing Experiments

Experiment 1

The change in the magnetic flux passing through the cross-sectional area of the coil is explained to pre-service science teachers based on the change in the position of the magnet in relation to the coil, and the amount of deflection of the galvanometer pointer can be observed using two coils with N=12,000 and N=1,200 (where N equals the number of turns in the coil). With such an implementation, pre-service science teachers can see that the induced emf is directly proportional to the number of turns in the coil.

Experiment 2

A second coil, which was located beside the first coil whose ends were attached to the galvanometer directly, was connected in series to the direct current output of a power supply and a switch (see Fig. 2). Direct current was supplied to the coil by the power supply, and the flux change was performed by opening and closing the switch. Then, the deflection of the galvanometer pointer attached to the other coil indicated the existence of an induced current.

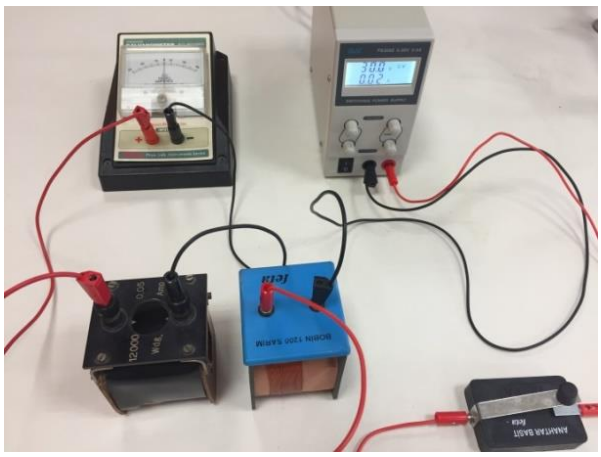

Figure 2 The experimental set-up for experiment 2

Experiment 3

A coil with 300 turns was first attached to the alternating current from the power supply. A LED diode was attached to the ends of the other coil with 12,000 turns and this coil was located in close proximity to the other coil; the two coils did not touch, and their axes coincided. When an alternating 10 V source is applied to the coil attached to the power supply, it will be observed that the diode attached to the other coil will light up as can be seen in Figure 3.

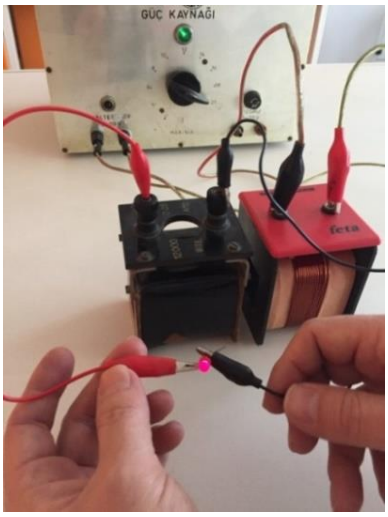

Figure 3 The experimental set-up for experiment 3

Experiment 4

The second coil with 1200 turns and a torch bulb connected is placed onto a coil with 300 turns around an iron bar located on a tripod. The second coil with 1200 turns and a bulb connected to its ends is held slightly above the lower coil with 300 turns connected to the power supply providing alternating current. In this way, when an alternating 10 V supply is initially applied to the first (lower) coil, the bulb is observed to light up. When the upper coil is moved vertically, the brightness of the bulb changes. Using the same mechanism, the experiment can be continued by applying direct current to the coil attached to the power supply, and a second coil is placed so that its axis coincides with the first coil (see Fig. 4).

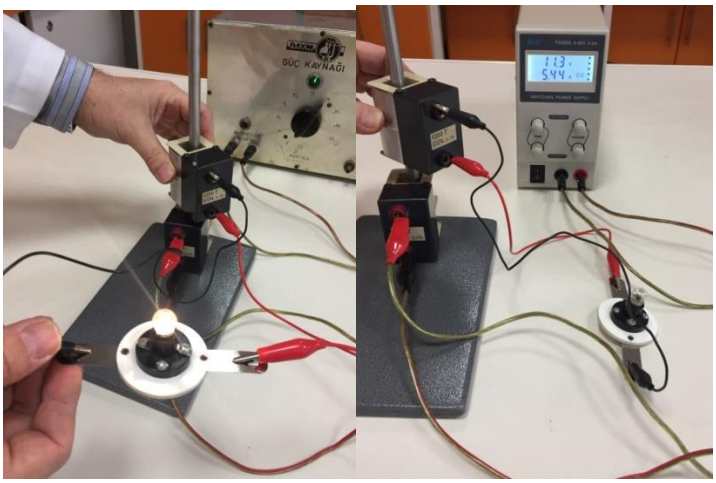

Figure 4 Pictures of the two experimental set-ups which were used in the experiment 4

Experiment 5

An aluminum ring is placed onto a coil with 300 turns around an iron bar located on a tripod. When an alternating 10 V source was applied to the coil, it was observed that the aluminum ring hung at a certain height above the coil. Using the same mechanism, the experiment can be continued by applying direct current to the coil attached to the power supply and adding an aluminum ring so that its axis coincides with the coil connected to the power supply, as illustrated in Figure 5.

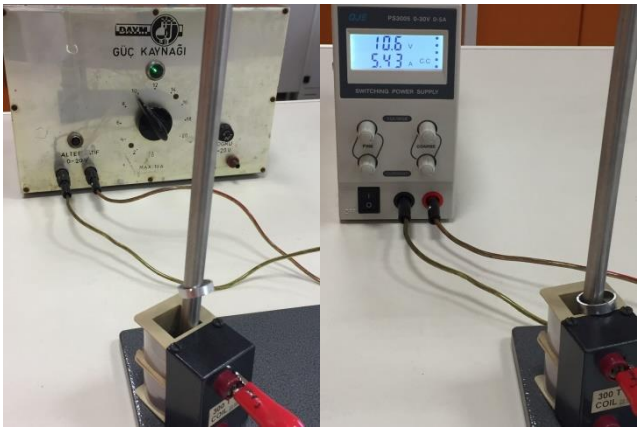

Figure 5 Pictures of the two experimental set-ups which were used in the experiment 5

Experiment 6

With the continuous ring on top of the coil attached to the power supply, a split ring can be placed beneath the continuous ring on the coil at this stage. When the alternating power supply is turned on, it was observed that only the continuous ring jumps on the coil.

Experiment 7

The presence of an induced current can be demonstrated using an aluminum pipe with a diameter of about 3.50 cm, a length of 80 cm, and a cylindrical permanent neodymium magnet with a mass of approximately 50 g instead of a coil. The aluminum pipe is placed vertically on the table and the neodymium magnet is allowed to drop under gravity from one meter above the table-top inside and outside the pipe, and the time when it hits the ground is measured. Additionally, a 50 g iron mass that does not show any magnetic characteristics was dropped inside and outside the same aluminum pipe at a height of one meter and the time to fall was measured. Therefore, the pre-service science teachers were provided with a comparison between the time to fall for both the magnet and the iron mass dropped from the same height.

Findings and Discussions

In this study, which aims to gain in-depth information about the demonstration experiments shown in online lectures, the findings related to the pre- and post-teaching interviews with the pre-service science teachers and the findings of the online survey are presented in this section. The findings are given in two sub-headings as pre-teaching and post-teaching findings below.

Pre-teaching Findings

Firstly, experiment 1 was carried out and when the pre-service science teachers were asked why the galvanometer needle was deflected by the movement of the magnet, all the interviewed pre-service science teachers thought that the coil was affected due to the magnetic field of the magnet. When asked how the coil is affected by the magnetic field, they mainly stated that the coil produced a current and deflected the needle. However, when further probed why the needle deflected when the magnet moved only, all pre-service science teachers left the question unanswered. For instance, pre-service teacher 1 explained that ''*when the magnet moves, the magnetic field is formed due to the action-reaction, then the movement of the magnet is necessary*''. On the other hand, pre-service teacher 2 reasoned that ''*there is a magnetic field around the magnet. It is like we can think of a ball on the ends of a magnet. When we thrust the magnet into the coil, we can think that the ball is squeezed, which causes pressure inside the coil and forms something. This formation produces tension on the wires of the coil and deflects the needle*''. Moreover, pre-service teacher 4 interpreted the deflection of the needle during the movement of the magnet using energy transformation with a correct approach. She responded that ''*it is related to the motion of the magnet. Do we increase its kinetic energy? Kinetic energy may be transformed into electrical energy. Since the kinetic energy is zero when the magnet is stopped, the current is not produced*''. None of the pre-service science teachers has yet used the concept of magnetic flux in the interviews.

In the next step of the experiments, experiment 2 was made and the pre-service science teachers were asked why the needle deflected when the switch was only turned on or off. All of the pre-service science teachers responded that the coil would produce a magnetic field when direct current is applied to the coil and that field was thought to have an influence on by creating a current in the other coil as in the previous experiment. Additionally, the pre-service science teachers tried to explain this event by making reference to the direct current. Below, part of the discussion with pre-service teacher 7 on this issue during the interview is presented.

Pre-service science teacher 7: *That means when we first turn off the switch at the direct current, the magnetic field is formed but after a while, it is not produced.*

Researcher: *Do you think that the magnetic fields created by direct current and alternating current are different*?

Pre-service science teacher 7: *I think it is very different*.

Researcher: *How is it different?*

Pre-service science teacher 7: *I wonder whether the current does not have enough power. It (current) may accept the coil as a resistance as long as the switch is turned on for a long time. That is why the needle is not deflected.*

Researcher: *So what would we see if we connected this coil to an alternating current supply?*

Pre-service science teacher 7: *I think the current always would reach a value and remain constant*.

Researcher*: Let's try it*. (The coil is connected to the alternating current supply). *What happened?*

Pre-service science teacher 7: *The needle is vibrating at the zero point*.

Researcher: *Is it what you think it is?*

Pre-service science teacher 7: *No, I was saying that the needle rotates up to a point and stops there. I am surprised now*.

Pre-service science teacher 7 knows that alternating current and direct current are different types of currents but cannot explain the situation in this experiment. Because, like other pre-service teachers, he focuses only on the formation of the magnetic field and cannot provide an idea about the concept of magnetic flux. Therefore, he tried to answer the question by considering that the magnetic fields of the two currents would be different. Similarly, pre-service science teachers 6, 9, and 2 put forward the idea that a time-varying current should exist and responded as follows: ‘‘*The alternating current provides discontinuous energy while the direct current gives continuous energy. Here, we turn the switch on and off, so we will create a discrete current, i.e. moving the magnet around the coil*’’.

In the next part of the interview, experiment 3 was presented to the pre-service science teachers and the reason for how the diode lighted up was asked. The pre-service science

teachers indicated in a similar manner to the previous explanations that a current would occur due to the interaction of the magnetic field with the coil to which the lamp was connected as long as the magnetic field was formed. Only four pre-service science teachers emphasized the need for alternating current and stated that a time-varying current could light up the diode. However, those pre-service teachers did not put any emphasis on flux change.

After talking about two set-ups related to direct current and alternating current, experiment 4 was performed to reveal what the pre-service science teachers think about a new situation. The pre-service science teachers suggested again that the current was formed in the upper coil only due to the magnetic field of the lower coil. When asked if the iron bar has an influence on the formation of the current, pre-service science teacher 1 and pre-service science teacher 6 explained that the bar had no function on the creation of current because the coils were not touching the bar either. However, the rest of the pre-service science teachers interviewed asserted that the rod would strengthen the magnetic field due to the fact that it was conductive. For example, pre-service science teacher 8 reasoned as follows: ''*Iron rod conducts the magnetic field. Maybe the bulb would not light up if there was not a rod. It basically increases the strength of the magnetic field*.'' The pre-service science teachers were asked whether the bulb would light up when a direct current was applied to the lower coil. Five of the pre-service teachers stated that the bulb would be less bright or might not light up. When asked for the reason for their arguments, they suggested that ''*the energy of the direct current is lower than the alternating current*" or ''*it was due to magnetic field which was not being created*''. The other four of the pre-service science teachers interviewed stated that the bulb would light up at first and then fade. Pre-service science teacher 3, for instance, explained that ''*the bulb goes on and then off in the direct current. Because the direct current is constant, there is no change. The magnetic field needs to be formed continuously. I thought the magnetic fields at the top and bottom coils would damp each other*''.

The interviews continued with experiment 5 involving the aluminum ring experiment. The pre-service science teachers argued that the magnetic field emitted from the coil enabled the ring to be rised above the coil by acting on the ring but they could not make a correct explanation. They also stated that the ring was affected by the magnetic field because it was made of aluminum, and if the ring was another kind of metal (such as iron), it would have been attracted by the coil. When the pre-service science teachers were asked to predict the temperature of the ring, they stated that the ring would be hot and pre-service science teachers 3, 4, and 5 commented that there might be a current transition between the ring and the iron

bar, while pre-service science teachers 1, 6 and 7 stated that the magnetic field might be passing through the ring.

The same experiment was made with a split ring. Pre-service science teachers 1 and 7 indicated that the magnetic field could not pass over the ring because of the slit in the ring and the ring did not rise by making reference to their earlier ideas in the interview. The other pre-service science teachers, who thought that the ring should jump upwards, stated that due to the magnetic field of the coil, it should jump slightly less than the continuous ring. However, when the experiment was performed and the discontinuous ring did not jump, for example, Pre-service science teacher 5 responded intuitively that ‘‘*the magnetic field could not pass through the slit and was unable to push the ring upwards because the ring was split*’’. Moreover, pre-service science teacher 4 made an inference on the basis of his observations in the previous ring experiment and responded as follows: ‘‘*So, the ring really had a current beforehand. Because the ring is split, there is no current on it and it does not jump then*’’.

Finally, the aluminum pipe experiment was performed and it was asked why the magnet fell late when it was allowed to drop under gravity inside the pipe. The pre-service science teachers stated that the magnet fell slowly due to the magnet being pulled slightly by the aluminum pipe. However, when the magnet was brought closer to the pipe later, they saw that there was no pull as they thought, and they were even more surprised. In particular, when pre-service science teachers watched the movement of the magnet from the top of the pipe, they understood that their assumptions completely lost their basis. Pre-service science teacher 6 explained his observation in the following way: ‘‘*Magnetic field lines are in the form of rings and the magnet goes down without hitting the walls of the pipe. The magnet is under the influence of its own field and it does not touch the pipe. First, I thought the magnet was slow because it touched the pipe's wall but that was not the case*’’. Pre-service science teacher 8 insisted on the idea of the push-pull effect and made the explanations in the transcript below.

Researcher: *What is the source of pushing or pulling?*

Pre-service science teacher 8: *Opposite charges create a force between the pipe and the magnet. I thought the same charges would push each other and the same rule works out here. Like the poles of the magnet and electric charges.*

Researcher: *Where do charges exist on the aluminum pipe?*

Pre-service science teacher 8: *Can not be scattered all over the pipe? Because the pipe is electrically conductive...*

Researcher: *So?*

Pre-service science teacher 8: *Perhaps, the magnet is interacting with the charges inside the pipe and slowing itself down.*

Although Pre-service science teacher 8 commented that charges could exist on the pipe, this idea is entirely based on the pre-service science teacher's alternative idea of mixing the electrical charges with magnetic poles. Therefore, the pre-service science teacher could not propose a correct explanation.

It can be seen from the pre-teaching interview data outlined above that the pre-service science teachers could not go beyond just explaining the questions related to the induction event depending on the magnetic field concept. Although some pre-service science teachers put forward correct ideas, they did not make any explanations about the change of the magnetic flux which is the key concept in answering the questions. The basic problem for many pre-service science teachers is the ability to interpret whether the flux passing through the cross-sectional area of the coil or the ring changes with time. Therefore, the concepts of flux and flux change have been tried to be addressed with all dimensions during the teaching process.

Post-teaching Findings

In the interviews conducted with the pre-service science teachers after the instruction, it was found that the pre-service science teachers abandoned their old ideas and they explained the events presented to them by focusing on flux change. The pre-service science teachers were able to express that not only the magnetic field would be sufficient when responding to the questions in the interviews, but also that the coils used in the experiments behaved differently when connected to the direct and the alternating current sources. The pre-service science teachers, who had difficulty in making explanations especially when direct and alternating currents were applied to the coil attached to the power supply before the instruction, could easily use scientifically correct arguments after the instruction. For example, the ideas presented by pre-service teacher 7 regarding the direct current in the interview transcript given above have changed as follows.

Researcher: *Why does the galvanometer pointer move when direct current is supplied to the coil by the power supply and the switch is turned on and off?*

Pre-service science teacher 7: *Direct current comes from the power supply. There must be a flux change for the induction current to occur. We cannot create such a flux change in*

direct current. We put the switch here and produce discontinuous currents, which in turn make the induction current in the other coil by changing the flux. Thus, the pointer is deflected.

Researcher: (Experiment 3 is performed) *Well, what happens in the LED connected circuit that we provide alternating current?*

Pre-service science teacher 7: *Here, we are able to create the flux change directly by means of the alternating current, so the LED is lit up by the induction current produced.*

After the instruction, the change of the ideas of the pre-service science teachers towards the scientifically correct notions shows that the teaching process enriched with different experimental setups was successful. Based on this result, pre-service science teachers were asked to comment about their lessons and experiments at the end of the interviews. The pre-service science teachers stated that this way of designing a teaching sequence on Faraday's Law was very effective and it was also important to see experiments in the order given during instruction. Pre-service science teachers 4 explained his views as follows: ''*I have easily grasped such an abstract event. In the pre-interview, I was just explaining the questions using the magnetic field. But I have actually seen that the concept of flux is important. I think if the first experiment with the magnet is well understood, the other experiments are easier to understand. I am most interested in the bulb experiment and the aluminum pipe experiment*''.

Pre-service science teacher 2 expressed the effectiveness of the experiments as follows: ''*If we had not watched the experiments, no one in the class would understand the events here. The experiments were both interesting and increased our curiosity about the topic*''. When asked which experiment was more effective in understanding the subject, she pointed out experiment four and explained the reason as follows: ''*This experiment shows how the alternating current, which constantly changes the flux, lights up the bulb and it also raises the reason why the brightness of the bulb changes when it is moved closer and farther to the lower coil. It also teaches the effect of the iron rod. It provides multiple things at the same time. I think it contains a summary of other experiments. I think it is more effective than the rest of the experiments. In addition, lighting up the bulb convinces me that the current passes through the coil to which the bulb is connected*''. For similar reasons, pre-service science teachers 1, 5, and 8 who were interviewed stated that the fourth experiment was effective in comprehending the induction phenomenon.

Pre-service science teachers 3 and 6 stated that in their pre-teaching interviews, they had difficulty especially because they had incorrect information about alternating current and direct current, but they could now explain the formation of induction current even in different situations. Moreover, Pre-service science teacher 6 expressed that all experiments completed each other in understanding the entire phenomenon of electromagnetic induction and emphasized that the aluminum pipe experiment impressed him very much.

Pre-service science teacher 7, on the other hand, indicated that the aluminum ring experiment, which is difficult to comprehend, plays a key role in the transition to different situations after being grasped. He clarifies this view by explaining that ''*when the difference between alternating and direct currents is known, the formation of the induced current can be better understood with two current types in the aluminum ring experiment*''.

When Table 2 is examined, the pre-service science teachers have found all of the experiments done reasonably effective. The experiment in the first place was experiment 4 in which the pre-service science teachers observed the light bulb burning as a result of the flux change in a concrete way. In addition, they stated that it is quite interesting and explanatory that the induced current does not occur when direct current is applied instead of alternating current. The second popular experiment is experiment 1, which is considered the first to be observed among 18 pre-service science teachers and is regarded as the main experiment. This experiment is in fact the first experiment of Faraday in 1831 to show the phenomenon of electromagnetic induction (Wikipedia, 2016). In this experiment, the formation of the induced current is indicated by the deflection of a galvanometer pointer when a bar magnet moves towards and away from a coil whose ends are attached to a galvanometer. Here, the magnet is the source of the magnetic field, and the intensity of the magnetic field passing through the plane of the coil changes in time to cause a change in the flux value according to the equation $\phi=B.A.\cos\alpha$.

Table 2 Pre-service science teachers' answers to the question 'which experiment was the most effective in online learning class?'

Experiment no	Number of pre-service science teachers (n=52*)	Types of pre-service science teachers' justifications
4	23	• It was possible to see whether the induction current occurred or not with direct and alternating current sources in the same experiment • Observing that the bulb was lit up without any power supply as a result of the change in flux caused us to believe that the current was

		formed and led to permanent learning
1	18	• Because it is easy to see flux change and pointer's direction of deflection by using a magnet.
5 & 6	13	• Such an experiment that gives you the opportunity to test multiple variables at the same time. • The function of the iron rod, the presence of the aluminum ring, what raises the ring, why the discontinuous ring does not rise and the alternating-direct current separation are all questionable.
7	11	• It is a magic demonstration and very interesting. All information is combined in this experiment. • From the early to the final stages of the experiment, versatile thinking is enhanced and encouraged.
2	7	• Someone can easily comprehend how the induced current is formed using the direct current. • Understanding that there must be a change in flux is revealed by this experiment.
3	4	• This experiment looked different because we used LEDs. Also, the fact that we used AC current here after the previous experiment had a significant impact.

*Some pre-service science teachers have commented on more than one experiment.

On the other hand, the pre-service science teachers, who preferred experiments 5, 6, and 7 in which aluminum ring and aluminum pipe were used respectively, emphasized that they did not encounter such set-ups before. Those experimental demonstrations were found to require high-level thinking skills and the ability to question more than one event at the same time. Moreover, data analyses show that the reasons for choosing the most effective experiments for both the whole class and interviewed pre-service science teachers were similar to each other.

Conclusions and Suggestions

In this study, an online teaching application using POE learning model and real classroom experiments was implemented to support the conceptual understanding of electromagnetic induction through distance learning. There were many situations in which pre-service science teachers had difficulty explaining conceptually before the instruction. After the instruction, on the other hand, the change of the ideas of the pre-service science teachers towards the scientifically correct notions shows that the teaching process enriched with different experimental setups was successful. This result of the study was consistent with the literature. There are many studies in the literature showing that the POE is an effective learning model (Fuadi et al., 2020; Harman & Yenikalayci, 2022; Nalkiran & Karamustafaoğlu, 2020; Tahir et al., 2020; Tereci et al., 2018; Yulianti et al., 2020). On the other hand, there are also studies showing that the use of the POE learning model in distance

education or computer-assisted instruction positively affects students' conceptual understanding and achievement (Alfiyanti et al., 2020; Astiti et al., 2020; Yang et al., 2021; Yaşar & Baran, 2020). In this study, in support of the literature, it was observed that the courses designed according to POE model in distance education helped pre-service science teachers to understand the subject better. Unlike the literature, in this study, a teaching application in which the real experiment videos prepared by the instructor and the POE model were handled together. It is thought that this study will contribute to the literature in this respect. Therefore, it can be suggested that the effect of real experiment videos through distance education should be investigated comparatively in different subjects and fields.

This research involves the teaching of electromagnetic induction in physics. The concept of magnetic flux in this subject can be expressed as a difficult concept that students tend to confuse with the concept of magnetic field. In the interviews conducted at the beginning of the study, the basic problem for many students is the ability to interpret whether the flux passing through the cross-sectional area of the conductor changes with time. For this reason, in the pre-interviews with the pre-service science teachers, the formation of the induced current was tried to be explained by the magnetic field. Similarly, it is stated in different studies that students experience the same difficulties (Albe et al., 2001; Guisasola et al., 2013; Mauk & Hingley, 2005; Thong & Gunstone, 2008; Zuza et al., 2016).

During the pre-teaching interviews, it was observed that only a few of the pre-service science teachers were able to correctly interpret the results of the experiments they encountered. The pre-service science teachers' erroneous explanations were dominated by the ideas that '*two objects act in the form of action-reaction forces*' or that force or current flows from the iron rod to the ring '*just like the flow of water*' as in the aluminum ring experiment. Similar ideas were also found in the studies of Loftus (1996), who investigated how the ideas of secondary school students aged between 14-18 years changed with age while interpreting the electromagnetic induction phenomenon, and Kocakülah (2003), who investigated the change in conceptual understanding of Faraday's Law between first and last year university students.

Before the instruction, the difficulty pre-service science teachers encountered in recognizing the causes of magnetic flux change caused them to be unable to explain how the induced current would be formed during the experiments with alternating or direct current. Although some pre-service science teachers knew that the two types of current have different properties, they could not fully explain their effects in the experiments and could not predict

whether the induced current would be formed especially when the alternating and direct current was used. Pre-service science teachers were asked to interpret the situations they observed using AC and DC currents in experiments 2, 3, 4, and 5. It was observed that some pre-service science teachers stated that '*direct current would not create a magnetic field*' or '*it would have no effect because it has a lower energy*'. To the best of our knowledge, this finding has not been observed in any previous study and is a result that emerged for the first time in this study. Although the pre-service science teachers knew that electric current has a magnetic effect, they could not explain why the lamp does not light or the ring does not move when DC is used, based on the flux change. In the interviews conducted after the instruction, it is observed that they have explained the situations they encounter in the light of the flux change. Additionally, they were able to consider the difference of the current type in generating the induced current after teaching.

The second aim of the study was to determine the pre-service science teachers' opinions about the real video experiments used during teaching. The first choice of pre-service science teachers on the shown videos is the experiment 4 in which a torch bulb has been used to generate an induction current by direct and alternating current sources. Then comes experiment 1 in which a galvanometer and a magnet have been used. The reasons for selecting these experiments also coincide with the purposes of conducting experiments during teaching, which is an important result of the effectiveness of the teaching process.

Throughout the research, some limitations were encountered in both the teaching process and the data collection process. In particular, the sudden transition to the distance education process due to the pandemic, the fact that some students had problems with internet connections and participated in the lessons via mobile phones because they did not have computers caused difficulties in communication. For these reasons, the data collection process was carried out with a single method by interviewing only a certain number of pre-service science teachers, and the conceptual understanding levels of the whole class could not be determined. During the lessons, written communication was made with pre-service science teachers who did not have microphones, which sometimes caused the lessons to be prolonged. Since similar problems are among the general limitations of distance education (Korkmaz & Toraman, 2020; LaRose & Whitten, 2000), the interviewed pre-service science teachers were selected among the volunteer pre-service science teachers who had no connection problems, and the semi-structured interview method was preferred in order to obtain detailed data during

the interviews. Thus, researchers who want to conduct a study based on distance education can be advised to be prepared in advance to solve technical problems.

The results of the study revealed that even in the distance education, the teaching of physics subjects can be efficient with a teaching process in which students are active and abstract concepts are made concrete through different experiments. Therefore, it is recommended that teachers should conduct experiments and make students active in physics lessons under any circumstances. In addition, in cases where it is not possible to conduct experiments, it is thought that the use of different simulations and daily life activities on the internet will contribute to students' understanding of physics topics.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

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CRediT author statement

The study was single authored and the whole process was carried out by the corresponding author.

Research involving Human Participants and/or Animals

The study involves human participants. Ethics committee permission was obtained from Balıkesir University, Science and Engineering Sciences Ethics Committee.

Fen Bilgisi Öğretmen Adaylarının Faraday Yasasını Anlamalarında Video Deneylerin Rolünün ve Algılanan Öneminin Çevrimiçi Öğrenme Ortamında İncelenmesi

Özet:

Bu çalışmada, gerçek deney videoları kullanılarak tasarlanan öğretimin fen bilgisi öğretmen adaylarının Faraday' ın indüksiyon yasası hakkındaki fikirlerinin gelişimi üzerindeki etkisini ortaya koymak ve öğretmen adaylarının indüksiyon olgusunu anlamalarında en etkili gördükleri deneyleri belirlemek amaçlanmıştır. Araştırma pandemi döneminde online olarak ve 52 birinci sınıf fen bilgisi öğretmen adayından oluşan bir örneklem ile yürütülmüştür. Öğretim sürecinde tahmin-gözlem-açıklama (TGA) öğrenme modeli kullanılmış ve öğretim öncesinde ve sonrasında dokuz öğretmen adayı ile yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Görüşme verileri, fen bilgisi öğretmen adaylarının öğretim öncesinde Faraday yasası hakkında birçok bilimsel olarak kabul edilemez fikre sahip olduğunu gösterirken tasarlanan öğretim sonrasında bu fikirlerin bilimsel doğrulara dönüştüğünü ortaya koymaktadır. Ayrıca, öğretimden sonra öğretmen adaylarının konuyu anlamalarında en etkili buldukları deney ya da deneyler belirlenmeye çalışılmıştır. Son olarak, online öğretimde kullanılan gerçek deney videoları ile desteklenen TGA modeline dayalı öğretimin başarılı olduğu sonucuna ulaşılmış ve bu konuda çeşitli önerilerde bulunulmuştur.

Anahtar kelimeler: TGA öğrenme modeli, uzaktan eğitim, Faraday yasası, fizik deneyleri, fen bilgisi öğretmen adayları

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Research Article

An Investigation of Digital Teaching Material Design Proficiency Levels in Terms of Various Variables

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Abstract – This research aims to examine pre-service science teachers' self-efficacy in developing digital teaching materials with web 2.0 tools according to various variables. The study was conducted by the quantitative research method and the survey model was utilized. The sample of the study consists of 450 pre-service science teachers studying at three different state universities in Turkey. Data were collected through the "Self-Efficacy Scale of Teachers' Digital Teaching Material Development." While analyzing the data; descriptive statistics, t-tests, and analysis of variance tests were used. According to the findings, the pre-service science teachers' self-efficacy in developing digital materials with Web 2 tools differed significantly according to their university, year of university education, and previous content development with Web 2.0. However, no significant differentiation was observed according to their gender. In light of all these results, it was found that pre-service teachers' proficiency in producing digital material using Web 2.0 is at a moderate level and differed significantly according to various variables.

Keywords: digital material, self-efficacy, web 2.0, pre-service teacher, science education

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Introduction

With the COVID-19 pandemic that appeared in December 2019, the importance of technology in education has increased. Teachers began to teach lessons through distance education and the online education system began to be used instead of face-to-face education.

In this period, the role of digital materials in education has gained more importance. Along with the use of digital teaching materials in the COVID-19 period, teachers' use of digital articles in the area being addressed should be reviewed. Such articles must be referenced accurately.

technology in teaching and their digital skills have improved. Their ability to use digital technologies has increased (Beardsley et al. 2021).

Teachers' self-efficacy level has significant importance on their ability to teach. A high sense of self-efficacy allows them to have positive teaching approaches and positive behaviors (Tavyl, 2014). Saavedra and Opfer (2012) stated that the nine principles that 21st-century teachers should pay attention to in setting up the learning environment are developing thinking skills, teaching-learning, teaching through science, associating concepts and subjects, showing mistakes, supporting the learning process with technology, directing teamwork, promoting knowledge transfer and improving productivity.

According to the standards of the International Society for Technology in Education (ISTE), the 21st-century teacher should have the roles of a leader, a collaborator, a designer, a citizen, an analyst, and a facilitator (ISTE, 2021). Teachers, who also assume the role of designers of education, need to consciously plan the use of technology to reinforce students' learning (McLeod, 2018). In this context, it can be said that the designer role of teachers is necessary for education. It can be thought that creating and designing content using Web 2.0 software will also contribute to the competencies of the teachers.

The Technological Pedagogical Content Knowledge (TPACK)

Technological pedagogical content knowledge (TPACK) is a structure based on the interaction of pedagogical and technological knowledge. Teachers should understand technology knowledge enough to use it in their workplaces and their daily lives and should know in which situation technology knowledge will help to reach the goal. In this sense, according to the TPACK view, technology knowledge encompasses a broader meaning (Mishra & Koehler, 2008). Öztürk et al. (2020) found that pre-service teachers' cognitive flexibility and techno-pedagogical education competencies were at a high level in their study. At the same time, it was found that techno-pedagogical competency did not differ significantly according to program type and gender but showed a significant difference according to the variables of having a computer and internet. Durusoy and Karamete (2023) used the Learning by Design (LBD) framework to develop pre-service teachers' TPACK

competencies. According to the results, there was a significant increase in pre-service teachers' TPACK competence levels as a result of the training provided with this framework.

Tatli et al. (2016) found a significant increase in the TPACK levels of teachers using Web 2.0 tools in their study. Choo et al. (2020) found a positive relationship between teachers' Web 2.0 self-efficacy and the level of integration of Web 2.0 tools into science lessons. In addition, Wright and Akgunduz (2018) found a positive relationship between TPACK self-efficacy beliefs and Web 2.0 content development. In addition, Öztürk et al. (2022) found that web 2.0 workshops improved pre-service teachers' techno-pedagogical competencies. The pre-service teachers were satisfied with the workshop.

Studies are showing a relationship between Web 2.0 self-efficacy and TPACK (Kul et al. 2019). In this study, the development of digital materials by pre-service teachers using Web 2.0 tools, one of the popular digital technologies of today, is examined. In this sense, the TPACK knowledge that teachers will gain can be associated with Web 2.0 usage and competencies. In this research, it is thought that determining the competencies of teachers in terms of the techno-pedagogical content approach is important in this regard.

Web 2.0 in Science Education

The use of digital materials has a key place in technology-supported education. While digital materials refer to the use of different media and resources such as internet resources, projectors, and computers and to present them through an electronic environment, non-digital materials refer to materials prepared with tools such as newspapers, paper, pens, money, beads, beans, and scissors (Howell & O'Donnell, 2017). One of the digital materials used within the scope of technology-supported education is the applications prepared with Web 2.0 tools.

The Web 2.0 trend has emerged as a current way of perceiving the internet in our age, and this has increased the influence of people involved in creating, sharing, promoting, and uploading several types of data (Krajka, 2012). One of the notable features of these Web 2.0 technologies is that they allow users to intervene and contribute to the content of web pages in line with the authorizations given to them without the need for technical knowledge (Karaca & Aktaş, 2019).

Web 2.0 tools create a suitable educational environment when used in a student-centered manner. For example, it is appropriate for a student-centered education for students

to write their comments and interact on a board created by the teacher on the Padlet. Or students can express their opinions on a blog. It can be said that the use of Web 2.0 applications in a student-centered and collaborative manner to develop students' problem-solving skills is quite beneficial. There are studies in the literature that support this idea. Research (Ravenscroft et al. 2013) shows that Web 2.0 technology supports active and collaborative learning of students and creates a student-centered environment. Web 2.0 technologies enhance collaboration and communication skills. With this technology, students can construct information and create a common product. In addition, this technology increases students' digital literacy levels (Magnuson,2013). Koehler et al. (2017) researched problem-solving-supported education. According to the results, it was found that web 2.0 tools played a role in facilitating learning and were effective in students' collaboration in problem-solving-supported education.

According to the other research results, it was found that Web 2.0-supported concept cartoons caused significant changes in students' attitudes and achievements (Gürleroglu,2019; Can & Usta, 2021). Yildirim and Gurleroglu (2022) examined the use of Web 2.0 in the "Force and Energy" unit during the pandemic process. They found that Web 2.0 tools positively affected the achievement and motivation of seventh-grade students. Cin Seker (2020), in his study with fifth-grade students, found that the Plickers application caused a significant difference in the academic success of the students.

Efficacy of Use Web 2.0

Web 2.0 tools led to significant differences in the achievement and attitudes of pre-service science teachers also. For example, according to a result of Korucu et al. (2020) research, the use of Web 2.0 technologies has increased the questioning skills and academic success of biology teacher candidates. In addition, these tools facilitate learning, improve collaboration, and make the lesson fun.

Habibi et al. (2020), examined the integration of digital materials by 217 Science teachers in Indonesia. It has been revealed that teachers' attitudes have a high impact on their level of integration and there is no significant difference in terms of integration according to their gender. In a study, the web 2.0 competencies of 217 science teachers were examined by demographic information. According to the results, there is no significant difference in their experience and gender. A significant difference was found by age (Dollah & Mahmud,2022). Kul et al. (2022) examined the content development competencies of 336 pre-service teachers with Web 2.0. According to the results, it has been determined that pre-service teachers'

information and communications technology competencies influence the development of their Web 2.0 self-efficacy.

Teachers' Self-efficacy

Teachers' self-efficacy level has significant importance on their ability to teach (Tavyl, 2014). Low self-efficacy and beliefs of teachers were defined as factors that hinder technology integration (Xiaobin et al. 2014; Tsai and Chai,2012). We think that pre-service teachers' preparation of technological content is worth investigating in terms of guiding the future of today's technology-supported education. Although studies on this subject have increased recently, we believe that there are not enough studies on the digital competencies of teachers.

Although there are similar scales measuring Web 2.0 self-efficacy in the literature, it was seen that the scale used in the study was used only once before but was applied to teachers. In addition, research was not conducted to include all variables in this study. This research aims to aid in filling that gap in the literature. Technology will become more widespread in education in the future, and the importance of a teacher's use of technology in the classroom is increasing. For this reason, we emphasize the importance of special research on teacher candidates' ability to integrate the technology they will use in their professional lives into their classrooms and prepare materials accordingly.

This research aimed to determine the self-efficacy of pre-service science teachers in developing digital teaching materials with Web 2.0 tools and to examine them according to their university, gender, year of university education, and previous content development with Web 2.0. To achieve this aim, the self-efficacy levels of the pre-service teachers were measured, and answers were sought to the following research question:

Is there a significant difference in the self-efficacy of pre-service science teachers in developing digital teaching materials with Web 2.0 tools in terms of their university, gender, year of university education, and previous content development with Web 2.0?

The sub-questions are as follows:

1. What is the digital teaching material proficiency of science pre-service science teachers?

2. Do pre-service science teachers' self-efficacy in developing digital teaching materials show a significant difference according to gender?

3. Do pre-service science teachers' self-efficacy in developing digital teaching materials differ significantly according to the university they attend?

4. Do pre-service science teachers' self-efficacy in developing digital teaching materials show a significant difference according to their year of university education?

5. Do pre-service science teachers' self-efficacy in developing digital teaching materials show a significant difference depending on whether they have previously developed course content with Web 2.0 software or not?

Method

Research Design

The study was conducted by the quantitative research method and the survey model was utilized. Survey models have three key features (Frankel & Wallen, 2009):

1. Characteristics or views belonging to a community are defined. The sample is suitable for the research is determined.

2. The answers given by the group members, who are the data sources, form the research data.

3. Data are collected from a representative sample of the population, not from the entire population.

Participants

The sample of the research consists of 450 pre-service science teachers studying in the Science Teacher Education Program in the Marmara Region in the 2020-2021 Spring semester. The distribution table of the pre-service teachers participating in the study by gender and the university they attended is given in Table 1:

Table 1 Distribution of Pre-Service Science Teachers Participating in The Study by Gender and University of Education

		Gender		
		Female	**Male**	**Total**
University	A	17	206	223
	B	13	110	123
	C	16	88	104
Total		46	404	450

Data collection

The scale was conveyed to the pre-service science teachers through the chat section during the online lectures held in Google Meetings and Zoom environments. The participants answered the questions on the scale within the time given to them.

Teachers' Digital Teaching Material Development Self-Efficacy Scale: This scale developed by Korkmaz et al. (2019) was used as a data collection tool in the research. Reliability analyses of the scale were performed by Korkmaz et al. (2019). The Cronbach Alpha reliability coefficient was found to be 0.961 by the researcher. The 5-Point Likert Scale consists of three factors and 38 items. The scale structure consists of 14 items constituting the "Web 2.0 Development" factor, 18 items constituting the "Design" factor, and six items constituting the "Negative Opinion" factor (Korkmaz et al. 2019). Korkmaz et al. (2019) determined that the scale is valid and safe because of their analysis.

Data Analysis

The collected quantitative data were analyzed with the SPPS 25 program. Variables in the scale were entered into the SPSS program for statistical analysis. Demographic information of pre-service science teachers was also added as a variable. The answers given by the pre-service teachers on the Likert-type scale were entered into the SPSS program as 1, 2, 3, 4, and 5, and variables such as gender, class, and university were entered into the system separately for each participant.

Missing and incorrect ones from the collected data were not included in the data set. The remaining data were entered into the program. When the data entry was completed, the average and standard deviation values of each sub-dimension of the scale were calculated. Skewness and Kurtosis values were considered for normality analyses. Since the Skewness and Kurtosis values varied between -2 and +2, it was decided that the distribution of all data was normal. Data analyses were performed using the One-Way Analysis of Variance (ANOVA) test and Independent Sample t-test (George & Mallery, 2010). The homogeneity of the variances was checked with the help of Levene's test. The level of homogeneity was found suitable for the ANOVA test. The Cronbach Alpha value was found 0.95 by the researcher. KMO and Bartlett's analyses were performed. The KMO value was found above 0.60. If the Cronbach Alpha value is 0.70 and above, it is considered appropriate in terms of reliability (Büyüköztürk, 2002).

Validity and reliability

The scale used in research developed by Korkmaz et al. (2019) was used as a data collection tool in the research. Reliability analyses of the scale were performed by Korkmaz et al. (2019). The Cronbach Alpha reliability coefficient was found to be 0.961 by the researcher. Korkmaz et al. (2019) determined that the scale is valid and safe because of their analysis. In this study, the Cronbach Alpha reliability coefficient was found to be 0.95.

Results and Discussions

Results

Results of the first sub-problem

A scale consisting of 38 items was applied to the pre-service science teachers who wanted to determine their digital material development self-proficiency. The data obtained were analyzed. To provide answers to the first question, standard deviation results, and the arithmetic mean were examined. The findings of digital material development self-proficiency levels according to the answers given by the pre-service science teachers are presented in Table 2:

Table 2 Descriptive Analyses of The Scores of Pre-Service Science Teachers From Digital Material Development Self-Sufficiency Scale By Dimensions

Dimensions	n	Minimum	Maximum	x̄	SD
Web 2.0 development	450	1.00	5.00	3.39	1.05
Design	450	1.00	5.00	3.80	1.07
Negative gaze	450	1.00	5.00	2.65	.89
Total	450	1.45	4.84	3.47	.73

Note. N = number of participants; x̄ = mean; SD = standard deviation

When Table 2 is examined, it is seen that the minimum value of the total self-proficiency scores of the pre-service science teachers is 1.45 and the maximum value is 4.84. The total average self-proficiency score of pre-service science teachers is 3.47. The highest average score was in the Design subdivision ($\bar{x}$= 3.80, SD=1.07). After the design subdivision comes points from the Web 2.0 development subdivision ($\bar{x}$= 3.39, SD= 1.05). The lowest average score belongs to the negative opinion subdivision ($\bar{x}$= 2.65, SD= 0.89).

Results of the second sub-problem

To determine whether the pre-service teachers' self-efficacy in developing digital teaching materials differed significantly by gender, analyses were made with the Independent Samples t-test. Analysis results are given in Table 3.

Table 3 T-Test Analysis Results of Pre-Service Science Teachers' Digital Material Development Self-Efficacy by Gender

Dimensions	**Gender**	**n**	**x̄**	**SD**	**df**	**t**	**p**
Web 2.0 Development	Female	46	3.41	1.05	448	.961	.337
	Male	404	3.25	1.05			
Design	Female	404	3.80	1.07	448	.277	.782
	Male	46	3.76	1.06			
Negative gaze	Female	404	2.65	.89	448	.196	.845
	Male	46	2.62	.97			
Total	Female	404	3.47	.74	448	.734	.463
	Male	46	3.39	.70			

Note. N = number of participants; x̄ = mean; SD = standard deviation; df = degree of freedom

According to the findings in Table 3, no significant difference was found in the level of self-efficacy between male and female pre-service teachers participating in the study ($p>0.05$). In addition to the absence of a significant difference, the self-efficacy score average of female pre-service teachers ($\bar{x}= 3.47$, SD: 0.74) is higher than the self-efficacy scores of male pre-service teachers ($\bar{x}= 3.39$, SD: 0.70).

Results of the third sub-problem

In digital material development, an ANOVA test was applied to determine whether the self-sufficiency of the pre-service science teachers showed meaningful differentiation compared to the university at which they studied. The results of the analysis are indicated in Table 4 and Table 5.

Table 4 Results of ANOVA Test Analysis results of Digital Material Development Self-Proficiency of Science Pre-service science teachers according to the University Where They Study

Dimensions	Source of variance	Sum of squares	SD	Mean squares	F	p	Significant difference	η^2
Web 2.0 development	In groups	16.134	2	8067	.7478	.001	B>A, B>C	.967
	Between groups	482.244	447	1079				
	Total	498.379	449					
Design	In groups	8.838	2	4419	3.857	.022	B>A, B>C	.983
	Between groups	512.150	447	1146				
	Total	520.988	449					
Negative gaze	In groups	2193	2	1096	1.358	.258		
	Between groups	360,843	447	.807				
	Total	363,035	449					
Total	In groups	7092	2	3546	6.665	.001	B>A, B>C	.971
	Between groups	237,846	447	.532				
	Total	244,939	449					

Note. SD = standard deviation; η2=effect size

In Table 4, the ANOVA test was applied to determine whether there was a significant difference for universities according to the answers given by the pre-service science teachers at different universities. When the findings were examined together with the findings in Table 5, it was determined that there was a significant difference between the design, web 2.0 development dimensions, and total self-proficiency scores of the pre-service science teachers compared to the universities ($p < 0.05$).

According to the universities, variance analyses were applied to examine self-sufficiency. It was concluded that the variances were distributed homogeneously because the sig>0.05 in the lower dimensions and total scores of the scale. It has been determined that there is a significant difference. Tukey post-hoc tests were performed to determine which universities made this difference.

Descriptive statistics were also used to determine which universities differed in favor of the difference, i.e., the direction of the difference. Standard deviation and average values were looked at. The illustrative statistics are presented in Table 5.

First, self-proficiency findings in the web 2.0 development subdivision were examined. It was determined that there was a significant difference between University B scores ($\bar{x}$= 3.69, SD=1.05) and University C score ($\bar{x}$= 3.20, SD=1.00) in favor of University B, and a significant difference between University B score ($\bar{x}$= 3.69, SD=1.05) and University A score ($\bar{x}$= 3.31, SD=1.04) again, in favor of University B ($p<0.05$). The effect size was calculated as 0.967. It shows that university has a "large effect" on teachers' web 2.0 development efficacy.

The findings of the design subdivision were also examined. As a result of the tests, it was determined that there was a significant difference between University B scores ($\bar{x}$= 4.02, SD:0.94) and University C scores ($\bar{x}$= 3.67, SD:1.08) in favor of University B, and a significant difference between University B score ($\bar{x}$= 4.02, SD:0.94) and University A score ($\bar{x}$= 3.73, SD:1.12) again, in favor of University B ($p<0.05$). The effect size was calculated as 0.983. It shows that university has a "large effect" on teachers' designing material efficacy. Looking at the total scores, the digital material development self-proficiency scores of pre-service science teachers studying at University B ($\bar{x}$= 3.67, SD:0.69) are significantly higher than pre-service science teachers studying at University C ($\bar{x}$= 3.34, SD:0.74) and University A ($\bar{x}$= 3.41, SD:0.74, $p<0.05$). The effect size was calculated as 0.971. There was no significant difference in negative view subdivision scores that were outside of these two subdivisions ($p>0.05$).

Table 5 Visual Statistical Results of Science Pre-service Science Teachers' Self-Proficiency in Digital Material Development by University

Dimensions	**University**	**n**	**$\bar{x}$**	**SD**
Web 2.0 development	A	223	3.31	1.04
	B	123	3.69	1.05
	C	104	3.20	1.00
Design	A	223	3.73	1.12
	B	123	4.02	.94
	C	104	3.67	1.08
Negative gaze	A	223	2.69	.91
	B	123	2.53	.91
	C	104	2.68	.83
Total	A	223	3.41	.74
	B	123	3.67	.69
	C	104	3.34	.74

Note. N = number of participants; $\bar{x}$ = mean; SD = standard deviation

Results of the fourth sub-problem

To determine whether the pre-service teachers' self-efficacy in developing digital instructional material differs significantly according to the class that they are studying, analyses were made with the ANOVA test. Analysis results are given in Table 6 and Table 7.

Table 6 Results of ANOVA test analysis of digital material development self-efficacy of pre-service science teachers by year of university education.

Dimensions	Source of variance	Sum of squares	SD	Mean squares	F	p	Significant difference	η2
Web 2.0 development	In groups	38.447	3	12.816	12.427	.000	3>1, 2>1	.922
	Between groups	459.932	446	1031				
	Total	498.379	449					
Design	In groups	13.560	3	4520	3.973	.008	3>1, 2>1	.973
	Between groups	507.428	446	1138				
	Total	520.988	449					
Negative gaze	In groups	7.419	3	2473	3102	.027	3>1, 2>1	.979
	Between groups	355.616	446	.797				
	Total	363.035	449					
Total	In groups	12.385	3	4.128	7917	.000	3>1, 2>1	.949
	Between groups	232.554	446	.521				
	Total	244.939	449					

Note. SD = standard deviation; η2=effect size

In Table 6, an ANOVA test was conducted to determine whether there was a significant difference in terms of years of university education according to the answers given by pre-service teachers. The obtained findings were analyzed together with the findings in Table 7. As a result, it was determined that there were significant differences in Web 2.0 Development, Design, and Negative Gaze sub-dimensions ($p<0.05$).

Analysis of variance was conducted to examine self-efficacy according to participants' years of university education. It was determined that the total scores and sub-dimensions of the scale were sig>0.05, and it was observed that the variances were homogeneously distributed. Therefore, in this case, where there was a significant difference, Tukey posthoc tests were performed to determine between which grades the difference was. Descriptive statistics were also used to determine which year of university education was in favor. While performing the analysis, the mean and standard deviation values were checked. Descriptive statistics of the results are presented in Table 7.

As a result, there was a significant difference in total scores and all sub-dimension scores. These dimensions are Web 2.0 Development, Design, and Negative Opinion sub-dimensions.

First, Web 2.0 development self-efficacy findings were examined. Related tests were applied. There was a significant difference between first-year pre-service science teachers' score ($\bar{x}$= 2.91, SD: 0.99) and third year pre-service science teachers' score ($\bar{x}$= 3.69, SD: 1.09) in favor of third year pre-service science teachers, and a significant difference between first-year pre-service science teachers' score ($\bar{x}$= 2.91, SD: 0.99) and second year pre-service science teachers' score in favor of the second year pre-service science teachers between the

scores ($\bar{x}$= 3.58, SD: 0.94, p <0.05). The effect size was calculated as 0. 922. It shows that grade has a "large effect" on a teacher's web 2.0 development efficacy. Statistics in the Design sub-dimension, which is the other dimension where significant differentiation occurs, were examined. Related tests were applied. There was a significant difference between first-year pre-service science teachers' score ($\bar{x}$= 3.54, SD: 1.02) and third year pre-service science teachers' score ($\bar{x}$= 3.87, SD: 1.17) in favor of first-year pre-service science teachers', and a significant difference between first-year pre-service science teachers' score ($\bar{x}$= 3.54, SD: 1.02) and second year pre-service science teachers' score ($\bar{x}$= 4.01, SD: 0.85) in favor of the second year pre-service science teachers (p< 0.05). The effect size was calculated as 0.973. It shows that university has a "large effect" on teachers' designing material efficacy.

A significant difference was also found in the Negative Opinion sub-dimension. In the Negative Opinion dimension, there was a significant difference between the first-year pre-service science teachers' score ($\bar{x}$= 2.86, SD: 0.80) and the third year pre-service science teachers' score ($\bar{x}$= 2.50, SD: 1.00) in favor of the third year pre-service science teachers and a significant difference between the first-year pre-service science teachers' score ($\bar{x}$= 2.86, SD: 0.80) and second year pre-service science teachers' scores ($\bar{x}$= 2.59, SD: 0.79) in favor of the second year pre-service science teachers (p <0.05). The effect size was calculated as 0.979.

Table 7 Visual Statistical Results of Science Pre-service Science Teachers' Self-Proficiency in Digital Material Development by Year of University Education

Dimensions	**Year of University Education**	**n**	**$\bar{x}$**	**SD**
Web 2.0 development	Firs year	105	2.91	.99
	Second year	125	3.58	.94
	Third year	103	3.69	1.09
	Fourth year	117	3.36	1.03
Design	Firs year	105	3.54	1.02
	Second year	125	4.01	.85
	Third year	103	3.87	1.17
	Fourth year	117	3.74	1.19
Negative gaze	Firs year	105	2.86	.80
	Second year	125	2.59	.79
	Third year	103	2.50	1.00
	Fourth year	117	2.65	.96
Total	Firs year	105	3.20	.66
	Second year	125	3.63	.59
	Third year	103	3.59	.82
	Fourth year	117	3.43	.79

Note. N = number of participants; $\bar{x}$ = mean; SD = standard deviation

Results of the fifth sub-problem

To determine whether the self-efficacy of pre-service science teachers studying in the Science Teaching Program in digital material development showed a significant difference compared to the pre-service science teachers' creating course content with Web 2.0, analyses were made with the Independent Samples t-test. Analysis results are given in Table 8:

Table 8 t-Test Results of Pre-Service Science Teachers' Self-Efficacy in Digital Material Development According to The Variable of Content Development With Web 2.0 Previously

Dimensions	Content	n	x̄	SD	df	t	p	η2
Web 2 development	Yes	275	3.73	.95	448	9.511	.000	.922
	No	175	2.85	.96				
Design	Yes	275	3.98	1.08	448	4.700	.000	.449
	No	175	3.51	.99				
Negative gaze	Yes	275	2.46	.91	448	-5.730	.000	.556
	No	175	2.94	.78				
Total	Yes	275	3.65	.74	448	7.023	.000	.689
	No	175	3.17	.62				

Note. N = number of participants; x̄ = mean; SD = standard deviation; df = degree of freedom

According to the independent t-test result, there was a significant difference between those who had previously developed course content with Web 2.0 and those who did not ($p<0.05$) Self-efficacy scores of those who had previously developed course content with Web 2.0 ($\bar{x}= 3.65$, SD: 0.74) were higher than those who had not developed it before ($\bar{x}= 3.17$, SD: 0.62). The effect size of the scale was calculated as 0.689. It shows that teachers' creating course content with Web 2.0 has a "large effect" on teacher's development material efficacy.

Discussion

With the COVID-19 pandemic that emerged in December 2019, the importance of technology in education has increased. Teachers started to teach via distance education, and the online education system began to be used instead of face-to-face education. With this situation, the necessity of using digital materials used by teachers during face-to-face education has also emerged in the online environment (König et al., 2020). It would be appropriate to use Web 2.0 tools for this purpose.

The widely adopted teacher-centered view of education may change under the lead of Web 2.0 technology (Butler, 2012). In research, it was found that Web 2.0 technologies are versatile technology that provides services for pedagogical purposes (Coutinho, 2008).

This study, it was aimed to find pre-service science teachers' sufficiency in digital material development with Web 2.0 tools according to various variables. The result of this research indicates that pre-service science teachers' digital material development self-efficacy is moderate. The highest mean score was experienced in the Design sub-dimension. Based on the findings, it can be said that pre-service teachers consider themselves more competent in design compared to the Web 2.0 development sub-dimension. After the design sub-dimension, the scores from the Web 2.0 development sub-dimension are up next. The lowest mean score belongs to the negative opinion sub-dimension. It can be said that pre-service science teachers do not have a negative view of developing digital materials in general.

It may be useful to examine the reasons for this result. It may be caused by the environment of the pre-service teachers or by their internal factors. Supporting this, teachers' self-efficacy is effective in using technology in their classrooms (Inan & Lowther, 2010). In other words, pre-service teachers' use of technology increases their self-efficacy; It can be said that those with high self-efficacy tend to use it more. Moreover, a meaningful relationship was found between teachers' computer self-efficacy and their ability to develop online assessment material. Teachers' digital efficacy is a positive indicator for their development of online assessment materials (Ninković et al. 2021).

According to Bandura (1977), self-efficacy is related to the self-efficacy level of the person before the action is taken. In other words, it can be thought that it is necessary to analyze the formation process of self-efficacy well. In this process, it can be said that the school of education also influences proficiency. A similar result was found in this study. According to the results, there was a significant difference between universities.

It was seen that the digital material development self-efficacy of pre-service science teachers shows a significant difference according to the university they study at. It was determined that the scores of pre-service teachers in Web 2.0 Development and Design dimensions and their total self-efficacy scores differed significantly according to universities. The pre-service teachers at B universities are more competent than the pre-service teachers at A and C Universities in developing and designing digital materials using Web 2.0. studies that measure digital material development self-efficacy according to universities were not encountered during the literature review. Some studies measure technological competencies according to the type of high school graduate. Tekerek et al. (2012) selected pre-service teachers from the Department of CEIT as a sample in their study. They measured computer

self-efficacy. There was a significant difference in favor of vocational high school graduates according to the type of secondary education graduated from. Likewise, it has been revealed that individuals who have previously used Web 2.0 are more confident in developing materials.

It was determined that the digital material development self-efficacy of pre-service science teachers shows a remarkable difference compared to their previous development of course content with Web 2.0. A significant difference was found among the prospective teachers who participated in the study in favor of those who previously developed course content with Web 2.0. Pre-service teachers who have previously developed course content using Web 2.0 software consider themselves more competent than those who have not developed it before. This result can be said to be effective in the fact that these pre-service teachers gain knowledge and experience in material development and design while developing course content with Web 2.0. A similar result was found by Alhassan (2017).

Similarly, Caner and Aydin (2021), in their study, found that Science and Foreign Language preservice teachers' digital self-efficacy score was above average. Akkoyunlu and Soylu (2010), in their study, found that teachers' digital technology competencies were moderate; When compared in terms of sub-dimensions, it was determined that their awareness and motivation were high, and their competence and technical access levels were moderate.

Unlike this result, Pan and Franklin (2011) found in their study that teachers have low self-efficacy in using Web 2.0 tools and they integrate Web 2.0 tools into their lessons with low frequency. Lei's (2009) findings verified that teachers are not ready to integrate Web 2.0 tools into their classrooms. The researchers also have confirmed that many teachers felt anxious about the integration, despite knowing the benefits of integrating Web 2.0 technologies into their teaching (Chen and Jang, 2014; Hew & Cheung, 2013).

It was seen that the digital material development self-proficiency of pre-service science teachers does not show any significant difference by gender. In addition to the similarity scores of male and female pre-service teachers, female pre-service teachers have higher digital material self-proficiency than male pre-service teachers. There was no significant difference in web 2.0 development, design, and negative opinion sub-dimensions. Similar results were found by researchers (Gökbulut et al.2021; Habibi et al.,2020; Kreijns et al. 2013; Say & Yildirim, 2020). Unlike this result, there was significant differences were found by researchers (Hao & Lee, 2015; Ocak & Karakuş, 2019; Sağlam, 2007; Yılmaz et al., 2015).

It was determined that the digital material development self-efficacy of pre-service science teachers shows a significant difference according to their years of university education. Second and third year pre-service science teachers' have a better level of self-efficacy in digital material development than first-year pre-service science teachers. It can be thought that the fact that the first-year pre-service science teachers have not yet completed the computer course in the undergraduate curriculum and that they have just started university can be the biggest factors in determining this result. Similarly, studies were conducted in which there were significant differences according to year of university education (Eser, 2020; Kozan & Özek,2019).

Yılmaz et al. (2015) conducted a study to determine the perceptions of primary school pre-service teachers about determining computer proficiency and using technology in education. There was no significant difference in terms of technology use and computer proficiency according to year of university education. Unlike this result, it was determined that there was a significant difference between participants' years of university education in this research.

Conclusions and Suggestions

In light of all these results, it can be said that the pre-service teachers' proficiency in producing digital material using Web 2.0 is at a moderate level. Content production with technological applications is a critical issue in teacher education. The fact that we live in the age of technology also requires having a certain technological competence. Teachers need to have a quality education process in Education Faculties. According to the information extracted from this study, it is recommended that the course contents be designed in a way that will improve pre-service teachers' self-confidence in producing digital materials. The material development course using Web 2.0 technology should be added to the curriculum of the Faculties of Education as an elective course or compulsory course by educational policymakers. In the teaching practice courses, qualified training can be given on the integration of Web 2.0 software into the Science course, which will contribute to the professional development of pre-service teachers. Besides, educational policymakers can take advantage of this study since the results can promote see teachers' self-efficacy. Moreover, teachers' Web 2.0 competencies should be modeled with academic studies and their reflections should be analyzed comprehensively.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

Authors declare no conflict interest.

Ethical Approval

Ethical Approval Ethics committee approval (Date: 15.02.2021,Number: E-73613421-604.01.02-2102150056) was obtained from our university for the information about the data collection tools and methods to be made on the self-efficacy of pre-service science teachers in developing digital teaching materials. In addition, necessary permissions were obtained from the three universities where the research was conducted.

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Öğretmen Adaylarının Dijital Materyal Yeterliklerinin Çeşitli Değişkenler Açısından İncelenmesi

Özet:

Araştırmanın amacı Fen Bilgisi öğretmen adaylarının Web 2.0 ile dijital öğretim materyali geliştirme özyeterliklerini farklı değişkenler açısından incelemektir. Araştırma kapsamında nicel araştırma desenlerinden tarama modeli kullanılmıştır. Araştırmanın örneklemi, 3 farklı üniversitede öğrenim gören 450 öğretmen adayından oluşmaktadır. Nicel veriler "Öğretmenlerin Dijital Öğretim Materyali Geliştirme Öz-yeterlik Ölçeği" ile toplanmıştır. Verilerin analizi SPSS 25 programı ile gerçekleştirilmiştir. Veriler analiz edilirken tanımlayıcı istatistikler, Tek Yönlü Varyans Analizi ve bağımsız örneklem t testi kullanılmıştır. Bulgulara göre öğretmen adaylarının Web 2.0 ile dijital materyal geliştirme özyeterliği; okudukları üniversiteye, sınıfa ve daha önceden Web 2.0 yardımıyla dijital materyal geliştirme deneyimi olma durumuna göre anlamlı derecede farklılaşma göstermiştir. Fakat cinsiyetlerine göre özyeterlik seviyelerinde anlamlı bir farklılaşma görülmemiştir.

Anahtar kelimeler: dijital materyal, özyeterlik, Web 2.0, öğretmen adayı, fen eğitimi

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Research Article

Investigation of Middle School Students' Area Measurement Knowledge and Skills

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Abstract – In this study, it is aimed to examine the area measurement knowledge and skills of middle school students. In the study, in which the descriptive method was used, the data were collected in written form with 8 open-ended questions from 92 seventh grade students. Students' answers to open-ended questions were analyzed with a scoring scale. The research shows that the majority of students who correctly estimate the size of the area measurement units are in the majority, but they have difficulty in transforming the standard area measurement units. Students who can calculate the area as the number of unit squares covering a region are in the majority. It was observed that the students who were successful in measuring the area of the rectangle had low success in measuring the area of the parallelogram, triangle and trapezoid, and it was observed that the students tended to multiply the two sides of the polygon while measuring the area. In addition, it was determined that some students confused the area with the environment.

Key words: area measurement knowledge, area measurement skill, geometry teaching, middle student.

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Introduction

Mathematics is an effective tool that helps individuals understand the world and the competency they should have for the beginning of a career (Dursun & Dede, 2004; Stafslien, 2001). Therefore, mathematics is taught as an introductory course at any level today, and mathematics skill is questioned as a fundamental skill in many national assessment and evaluation exams for the selection of students. Success in mathematics lessons is highly related to IQ, a sign of giftedness (Konold & Canivez, 2010). Therefore, students see

mathematics as an important lesson and a tool for life (Yaman & Yaman, 2020). Students only sometimes have positive feelings about mathematics, which is an essential course. Lim and Ernest (1999) stated that many students have negative thoughts about mathematics, and even teachers and parents have these negative thoughts. While there are many reasons for this, one of the main reasons is that mathematics is considered a complex subject to achieve. Although there are many reasons for the student to have this perception, both from the teacher, family, and friends, the student's failure in the course as an individual factor is essential (Savaş et al., 2010). In many countries, studies aiming at making students successful in mathematics are carried out to eliminate the perception that mathematics is complex (Şahin, 2013). In our country, the "Mathematics Mobilization" studies (MEB, 2022), which were initiated in cooperation with the Ministry of National Education, TUBITAK, and universities, in order to both facilitate the learning of mathematics by adapting it to daily life skills and to ensure that students like this lesson from a young age, continue actively.

Many factors affect students' success in mathematics. Thomson et al. (2003) discussed the factors affecting students' success under four headings: student attitude, student-related factors, teacher factor, and school factor. The researchers, who considered the affective components such as the student's anxiety towards mathematics, and the perception of self-efficacy under the student attitude, considered the components such as the thought, age, and experience of the individual's teacher with mathematics teaching under the teacher factor. Stating that the success of the student is affected by the technological facilities of the school, its perspective on education, its size, and the student-parent profile, Thomson et al. (2003) finally discussed the components such as the student's gender, family structure, socioeconomic status, and cognitive characteristics under the title of student-related factors. Students' knowledge and skills about a mathematical concept and subject also affect mathematics achievement (Şenol et al., 2015).

Therefore, studies examining students' knowledge, skills, and learning difficulties regarding mathematical subjects and concepts are frequently encountered in the literature (Çavuş Erdem, 2013; 2018; Öztürk & Gürefe, 2021; Tan Şişman & Aksu, 2009). Explaining students' deficiencies and mistakes in mathematical concepts is also crucial in paying attention to these issues in the design of instruction. Based on this idea, this study aimed to examine the knowledge and skills of secondary school seventh-grade students on area measurement.

Although making mistakes and experiencing difficulties in learning mathematics subjects are a natural part of the learning process of students (Hansen, 2014), it negatively affects their learning. Mathematics is a cumulative course with significant prerequisite knowledge. Therefore, student mistakes on a subject create an obstacle in learning other subjects that are fundamental to that subject, making it difficult to fully learn the subject. The subject of area measurement is the basis for volume measurement and land measurements, and it is also used as an effective tool in associating mathematical concepts such as algebraic expressions and identities (Bingölbali & Çoşkun, 2016). Therefore, it is important to identify students' errors and difficulties in measuring area, because detecting the mistakes and misconceptions at an early stage will enable the problem to be solved more easily. In addition, the student mistakes regarding the subject reveal important points about how the subject teaching should be designed and which issues should come to the fore. It is very important to increase teacher awareness on this issue. It is stated that some of the student errors are pedagogical, in other words teaching-related (Bingölbali & Özmantar, 2009). Therefore, conducting studies that determine the level of students' knowledge and skills and which subjects they learn incorrectly makes important contributions from the teacher and student perspective. Considering the studies that emphasize that students' learning deficiencies and obvious errors on the subject are caused by the curriculum (Yorulmaz & Önal; 2017), it is thought that studies examining students' knowledge and skills will also provide important information for program developers. Based on this idea, this research aims to examine the knowledge and skills of seventh grade secondary school students about area measurement and to reveal their learning deficiencies.

Area measurement

One of the learning fields of the mathematics curriculum is measurement, and one of the sub-learning is area measurement (MEB, 2018). *Area measurement* is an important concept that affects the understanding of mathematics subjects in upper grades (Cavanagh, 2008). Because area measurement represents a transition in teaching other measurement types, such as volume (Smith et al., 2016). Therefore, area measurement gains are at every grade level from the third to the seventh grade in the curriculum (MEB, 2018). Area measurement is expressed as determining the amount of a region in terms of a unit (Fauzan, 2002). Two essential concepts emerge in area measurement. These are the concept of area and the concept of measurement. The concept of area refers to the amount that covers a limited space, and measurement determines this amount with a unit (Simon & Blume, 1994). The first stage

involves understanding that the area is a planar region, that is, interpreting the area conceptually. In the second step, the amount is determined. Studies indicate that students need to clarify these two concepts and consider the area separate but interpret it as area measurement (Huang & Witz, 2013). It is important to emphasize these two concepts separately while teaching area measurement in order to prevent mistakes in teaching the subject.

In learning area measurement conceptually, it is necessary to pay attention to some issues. Clement and Stephan (2004) stated that in order to avoid rote learning in area measurement, at least five basic structures should be learned: a) segmentation, b) unit repetition, c) area conservation, d) structuring of the sequence, and e) linear measurement. The individual needs to understand that the structure to be calculated is a limited region and that the units should not overlap or be covered so that there are no gaps when covering the region (partitioning). Afterwards, with the repeated use of a unit of the same type and appropriate size determined, that region needs to be covered (unit iteration). The same type and suitable unit of measurement means a unit suitable for the structure of the covered plane, covering it entirely and leaving no spaces. Covering perpendicularly intersecting polygons such as rectangles and squares gives an idea of the area covered by circles or triangles but covering them with a square gives more precise information (Freudenthal, 1983, as cited in Zacharos, 2006). For the individual to cover it correctly with the appropriate unit at this point, it is also essential to know that the shape's area will not change regardless of the structure of the shape as long as the piece decreases or not (conservation of area). In this way, the area to be calculated can change the area to be covered more quickly.

After covering the region with units, the individual must determine how many units are in the row and column and understand that the region is a two-dimensional structure (Constructing the array). By covering a rectangle with appropriate and equivalent units, calculating how many units correspond to each line and how many from each line brings systematic counting to the fore (Outhred & Mitchelmore, 2000). Finally, the individual needs to understand how to obtain the total number of units covering the area by multiplying two dimensions and making the necessary association. It is essential to see the column-row coordination in the transition of area measurement to multiplicative dimension and to associate it with the product of the side lengths (Huang & Witz, 2013). Thus, it is possible for students to conceptually understand the multiplication process in the area formula (Outhred & Mitchelmore, 2000; Van De Walle et al. 2014). In this manner, it is possible to understand

mathematically the "area=length x width" algorithms based on rote measurement in traditional teaching. It is essential to plan by considering these issues in the curriculum and course contents prepared within the scope of teaching the subject of area measurement.

Our mathematics curriculum includes area measurement gains from the 3rd grade (MEB, 2018). In the program, a progress process in the form of covering the area of shapes with non-standard material, covering with unit square, establishing the relationship between the area relation of square and rectangle and the number of unit squares, measuring using standard units, and finally applying and interpreting this information is discussed (MEB, 2018). In this context, a teaching approach similar to the explanations above is adopted in the program. However, the effectiveness of this teaching style adopted in the program in student learning depends on how much it is carried into the classroom environment. Because researches indicate that students have misconceptions about measuring the area and make incorrect measurements (Çavuş Erdem, 2018; Çelik, 2023; Gelici, 2022; Gürefe, 2018; Huang & Witz, 2013; Kamii & Kysh, 2006; Kidman & Cooper, 1997; Orhan, 2013; Olkun Çelebi et al., 2014; Tan Şişman & Aksu, 2009; 2016). Kamii and Kysh (2006) revealed in their studies that students do not think of the unit square as a unit of measurement for the area. Kidman and Cooper (1997) stated that students made mistakes while calculating the rectangle area by adding the side lengths. Tan Şişman and Aksu (2009, 2016) stated that half of the students in their study did not have area conservation, and they confused area and environment. Orhan (2013), in his study, similarly concluded that students did not have area conservation; they needed help finding the circumference of a polygon whose area measure was given, and procedural knowledge was emphasized. Huang and Witz (2013) stated that the conceptual understanding of the area measurement formula directly affected the area measurement performance, and students who used the area measurement formula by heart exhibited poor performance. In their study, Olkun et al. (2014) concluded that students did not accept the unit square as a unit of area and tend to use formulas. Gürefe (2018), in her study, in which she determined the strategies used by students in area measurement problems, concluded that students commonly used formulas in triangle and rectangle-related problems, and they tended to use multi-step strategies when measuring area in rhombus and trapezoid. Kaya (2019) concluded that the students did not fully know the area concept and that the procedural dimension was emphasized. Gelici (2022) stated that the students had an incorrect concept image in measuring the area. They confused the area and the environment. Çelik (2023) stated in his study that students had less difficulty covering a shape with unit squares, and they could

not associate the measurement process with the unit used when measuring the area of a polygon.

Revealing the problems in the basic subjects of mathematics is important in order to plan future learning by solving these problems (Önal & Aydın, 2018). Because unless errors are corrected, they lead to misconceptions (Yenilmez & Yaşa, 2008) and increase the possibility of failure in mathematics. Therefore, early detection of student errors is very important. Based on this idea, this research aims to determine the level of student knowledge and skills regarding area measurement, which is an important sub-learning area of the mathematics basic education program, and to reveal their learning deficiencies. In the research, student knowledge and skills regarding different basic concepts of area measurement such as square unit, area measurement skill, conversion of standard area measurement units, circumference-area relationship were discussed together. Thus, it is aimed to present a general picture of student information on the subject of area measurement. There are a limited number of studies that examine student knowledge of the basic concepts of area measurement together (Tan Şişman & Aksu, 2009). Therefore, it is thought that the study will contribute to the literature. The research also asked questions about how students could calculate area measurement both with the help of unit square and area relation, thus aiming to determine student awareness about two important components that are critical in the conceptualization of area measurement, as stated by Stephan and Celement (2001). Another important issue in learning measurement is to understand the measurement unit correctly (Yenilmez & Pargan, 2008). Learning the measurement unit also includes the conversion skill of standard measurement units (MEB, 2018). This skill is directly related to the student's awareness of the quantity of the unit of measurement. It is obvious that a student who does not know the size of the measurement unit cannot learn unit conversion and the use of units in area measurement at a conceptual level (Van De Walle et al., 2014). Therefore, studies that determine students' knowledge about the amount of area measurement units were thought to be important. It is thought that this research, which examines students' knowledge and skills regarding the conversion of standard area measurement units and their awareness of the quantity of these units, will contribute to the literature in this sense.

Thus, the problem of the research is "“What are the knowledge and skills of seventh grade secondary school students on area measurement?" and within the scope of this problem, answers are sought to the sub-problems presented below.

1. What are the knowledge and skills of seventh grade secondary school students regarding measuring the area of spaces covered by unit squares?

2. What are the knowledge and skills of seventh grade secondary school students regarding standard area measurement units?

3. What are the knowledge and skills of seventh grade secondary school students regarding measuring the area of geometric shapes (square, rectangle, parallelogram, triangle, trapezoid)?

Method

Research Design

The case study method was adopted in this research. Case study is a research method in which the situation is described by collecting detailed and in-depth information about a system through limited situations (Creswell, 2020). While a single case about the problem or research topic addressed in the case study can be examined, results can be obtained by examining more than one case study within the framework of the same problem. In this research, where the descriptive feature of the case study (Yin, 2009) came to the fore, the knowledge and skills of middle school students on area measurement were examined in detail through open-ended questions on 92 students.

Participants

The research participants comprised seventh-grade students in the second semester of the 2018-2019 academic year. The achievements of the area measurement subject are included in the curriculum from the third grade, and it is planned to give a large part of the acquisitions until the seventh grade (MEB, 2018). Since it was aimed to present a general picture of students' area measurement information, seventh-grade students were thought to be the most appropriate sample group for secondary school. In the research conducted with 92 students, 52 were female, and 40 were male. Participants were studying in three different secondary schools located in a city center. A class from each school was determined, and all students studying in that class participated in the research. While determining the classes, attention was paid to ensure that the mathematics grade point average was at a medium level, and that students with high (between 80-100 points), medium (50-80 points) and low academic achievement scores (between 20-50 points) were included in a balanced manner. Thus, an attempt was made to ensure data diversity by creating heterogeneous groups. To that end, classes were determined by considering the first semester grade point average of the

mathematics course and the opinions of the mathematics teacher, and the application was carried out with a total of 92 students from three classes.

Data collection

In the research, the "Area Knowledge Evaluation Form" in the study of Çavuş-Erdem (2018) was used to measure the students' area measurement knowledge and skills. The questions in the form and the related acquisitions are presented in Table 1.

Table 1 The Acquisitions Related to the Questions in the Area Knowledge Evaluation Form

Question	Related Outcome
Question1	Being able to determine that the areas of the shapes are the number of unit squares covering this area and to compare the areas of the shapes
Question2	Calculating the area of a rectangle, using square centimeters, and square meters
Question3	Being able to recognize standard area measurement units
Question4	Solving problems related to the area of a parallelogram.
Question5	Comparing the areas of polygons
Question6	Interpreting the side-length-area relationship, calculating the area of the square
Question7	Solving problems related to the area of a triangle
Question8	Being able to solve problems related to the area of a trapezoid.

The form consists of eight open-ended questions. The questions in the form were determined by within the scope of the achievements in the seventh grade and previous years' curriculum. Before the application, a short explanation was given to the students about the questions in the form, and they were asked to write down the reason for the question along with the answer and to explain what they thought transparently without worrying about whether it was a wrong or correct statement. All of the applications were carried out under the researcher's supervision, and the application was completed in 40 minutes to enable the students to think about the questions sufficiently.

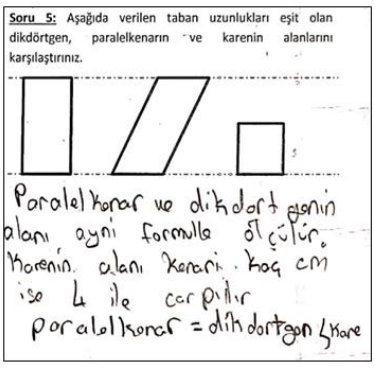
Data analysis

The scoring scale developed by Gürbüz & Birgin (2012) and presented in Table 2 was used to analyze the data consisting of open-ended questions.

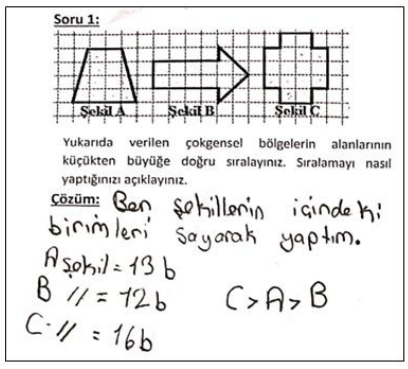
Table 2 Open-Ended Questions Scoring Scale

Levels of Understanding	Explanation	Evaluation Criteria Stage 1 – Stage 2	Score
Correct explanation	Answers that include all aspects of a valid explanation	Correct answer – correct explanation	5
		Wrong answer correct explanation	4
Partially correct explanation	Answers that do not include all aspects of the valid explanation	Correct answer – partially correct explanation	3
		Wrong answer - partially correct explanation	2
Wrong explanation	Answers with inaccurate information	Correct answer – wrong explanation	1
		Wrong answer – wrong explanation	0
No explanation	Correct, incorrect or blank answers with no explanation	Correct answer - no explanation	1
		Wrong answer - no explanation	0
		No answer - no explanation	0

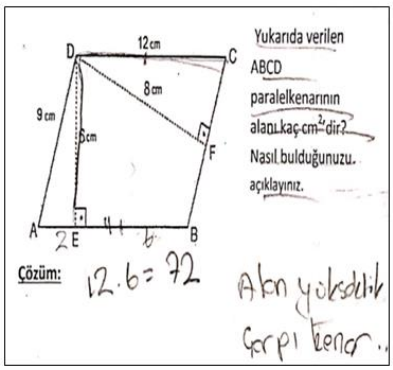
Each student's answer was coded separately according to the categories above. In order to detail the analysis framework, sample student answers and explanations are presented below (Figure 1). In the first example, the student gave a correct answer, but the explanations he wrote for both the area relationship of the rectangle and parallelogram and the area relationship of the square were wrong. Thus, the student's answer was coded in the "Correct answer - Wrong explanation" category. In the second example, the student gave the wrong answer. However, he stated that he made calculations by counting units when calculating the areas of regions and made a correct statement. However, since the student used the unit expression instead of unit square, the student's answer was coded in the "Wrong answer - Partially correct explanation" category. In the third example, the student correctly calculated the area of the parallelogram, but expressed the area relationship as the product of height and side instead of height and base. Thus, the student answer was coded in the "Correct answer- Partly Correct explanation" category.



The area of a parallelogram and rectangle is measured by the same formula. The area of the square and its side in cm are multiplied by 4. Parallelogram = Rectangle > Square



I did it by counting the units in the shapes.



Area, height times side

Figure 1 Student Answers

For the data analysis, assistance of an expert researcher was received. Accordingly, 19 student solution sheets, which constituted 20% of the data, were individually coded by two researchers. Afterwards, the researchers came together and compared the coding in detail. For the coding agreement percentage, Miles and Huberman's (1994) coder reliability formula ([Compatible codes/ (Consistent codes + Incompatible codes)] x100) was applied, and the agreement percentage was determined as 134 compatible codes-152 total codes). Incompatible codes were evaluated, and after a consensus was reached, the researcher carried out the analysis process alone. Each student paper was coded according to the scoring scale, and the coding results presented with frequency and percentage values were supported by sample student solutions based on each question. Translations of student explanations in the solutions are presented below the visual of the solution.

Results

In the study, student answers were evaluated both based on questions and students' performances. The distribution of the student's answers and the scores they got from the form is presented in Table 3.

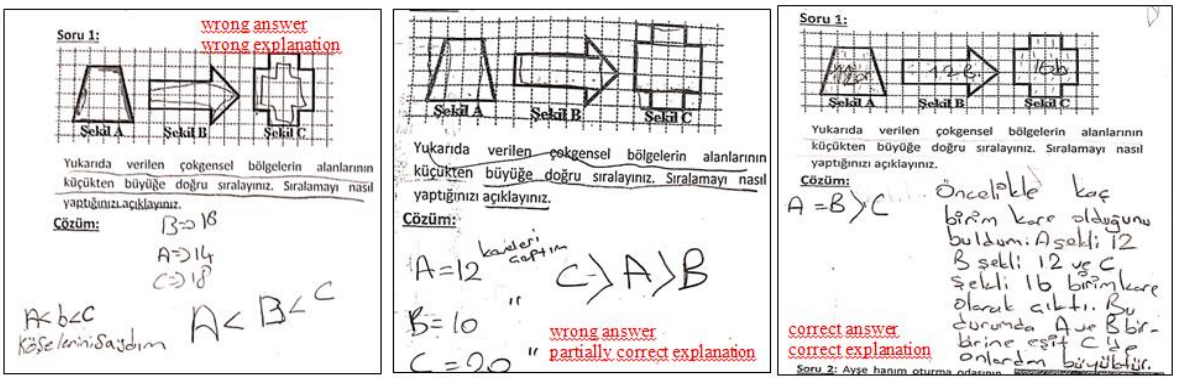
Table 3 Distribution of Student Answers

	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Mean
	f	%	f	%	F	%	f	%	f	%	f	%	f	%	f	%	%
Correct answer-correct explanation	22	24	8	9	50	54	14	15	9	10	1	1	26	29	16	17	20
Wrong answer-correct explanation	13	14	0	0	0	0	1	1	0	0	4	4	3	3	6	7	4
Correct answer-partially correct explanation	0	0	5	5	12	13	1	1	15	16	1	1	1	1	0	0	5
Wrong answer-partially correct explanation	22	24	31	34	4	4	25	27	10	11	21	23	15	16	15	16	19
Correct answer-wrong explanation	1	1	1	1	9	10	2	2	14	15	0	0	0	0	0	0	4
Correct answer-no explanation																	
Wrong answer-wrong explanation	34	37	47	51	17	19	49	54	44	48	65	71	47	51	55	60	48
Wrong answer-no explanation																	
No answer-no explanation																	

	Unsuccessful (0-8 p)		Must be developed (9-16p)		Acceptable (17-24p)		Good (25-32p)		Very Good (33-40p)	
Total	f	%	F	%	f	%	f	%	f	%
	32	35	29	32	21	23	8	9	2	2

Considering the information in the table, it was noted that the average percentage of students that gave correct answers with correct explanations was 20%, and the cases where they made correct explanations but gave wrong answers by making mistakes was four percent on average. While the average of the students who gave partially correct explanations with the correct answer was five percent, the average of those who gave partially correct explanations with the wrong answer was 19%. While students who gave correct answers but had incorrect or incomplete explanations were in the four percent group, students that gave both answers and explanations incorrectly or missing were the group with the highest percentage with an average of 48%. Based on the question, it was noted that the students gave correct answers only in the third question, with 54% of the correct explanation. The most significant percentage of the other seven questions belonged to the level with incomplete or incorrect answers and explanations. Considering the students' individual scores in the evaluation form, 35% of the students received weak scores and were unsuccessful. 32% of the students were in the must-be-developed group, and 23% scored at an acceptable level. Very few students could score in the good (nine percent) and very good (two percent) categories. In light of this information, it was possible to note that the students exhibited an unsuccessful performance in area measurement in general. The questions will be discussed individually, together with sample student solutions, to detail the cases where students were successful and unsuccessful.

In the first question, to compare the areas of regions consisting of unit squares, 24% of the students gave the correct answer with the correct explanation. 14% of the students counted the unit squares when comparing the areas but made a calculation error. Instead of counting unit squares, 24% of the students tried to calculate the area by converting the given shapes into familiar quadrilaterals such as rectangles and found incorrect results. On the other hand, 37% of the students were unsuccessful in this question and gave wrong answers and explanations. Sample student answers to the situations mentioned below are presented.



I counted the corners

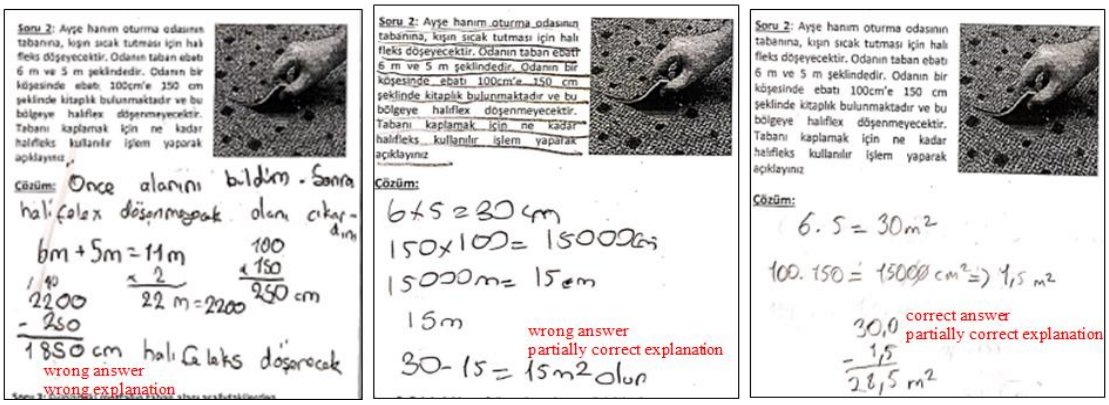
I multiplied the squares

First of all, I found out how many square units there are. Shape A turned out to be 12 square units, shape B 12 square units, and shape C 16 square units. A and B are equal to each other, and C is greater than them.

Figure 2 Student Answers to the First Question

Considering the student explanations, it was noted that the student in the first image was trying to calculate the circumference of the shapes to calculate the area. In the second image, the student calculated the area by converting all shapes into rectangles. The result was incorrect because student should have paid more attention to some unit squares. In the third image, it was noted that the student reached the correct answer by using the unit squares. The students who reached the correct answer accepted the area as the number of unit squares covering a region; in this sense, they had conceptually correct information.

The second question of the study was one that students needed help with. Only 14% of the students reached the correct answer in calculating the area of the rectangle and unit conversion, while the majority, 51%, answered the question incorrectly or left it unanswered. On the other hand, 34% of the students showed a partially correct solution approach. Sample student solutions to the question are presented in Figure 3.

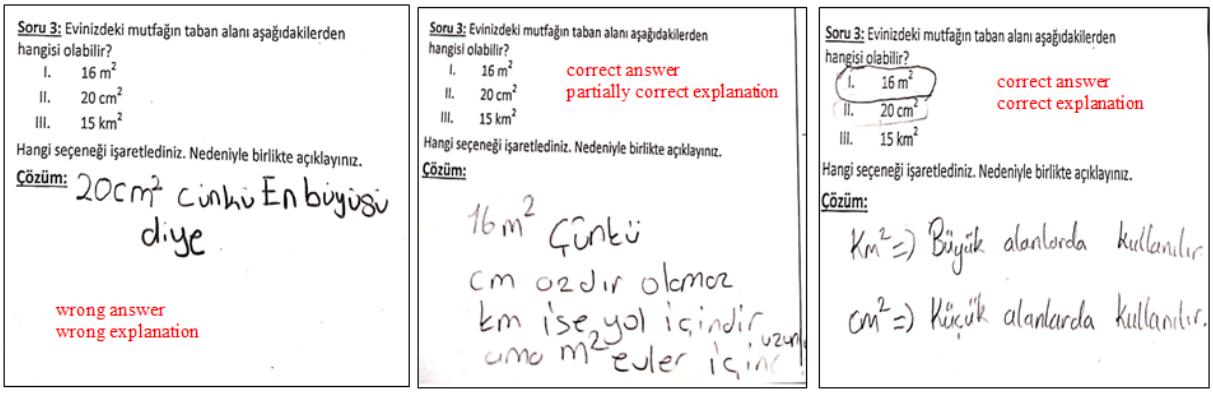


First, I found the areas. Then I removed the area that would not be carpeted.

Figure 3 Student Answers to the Second Question

When the students' answers were examined, it was seen that the student who gave the wrong answer added the side lengths to find the floor area of the room and made the unit conversion as m-cm correctly. The student confused the area with the circumference. In the second and third images, the students correctly calculated the area of the rectangle. Students who correctly calculated the area of the rectangle in this question constituted 49% of the group. However, students made the unit conversion incorrectly, therefore the students in the group who partially gave correct explanations gave wrong answers. In the second example, it was seen that the student also uses m and cm as units of area measurement. The findings obtained from this question showed that students need to improve in standard area measurement units and conversion between units.

The third question was about using area measurement units in daily life. In the question in which the students showed the most successful performance, 19 of the group gave the wrong answer, and 54% gave the correct answer with the correct explanation. 13% of the students who gave partially correct explanations gave correct answers, four percent gave incorrect answers, and the students who made a wrong explanation with the correct answer or did not make any explanation constituted 10% of the group. Sample student solutions are presented in Figure 4.



20 cm^2. Because it is the biggest

It's not possible because it's too small in cm. km is for the road. m^2 is for houses

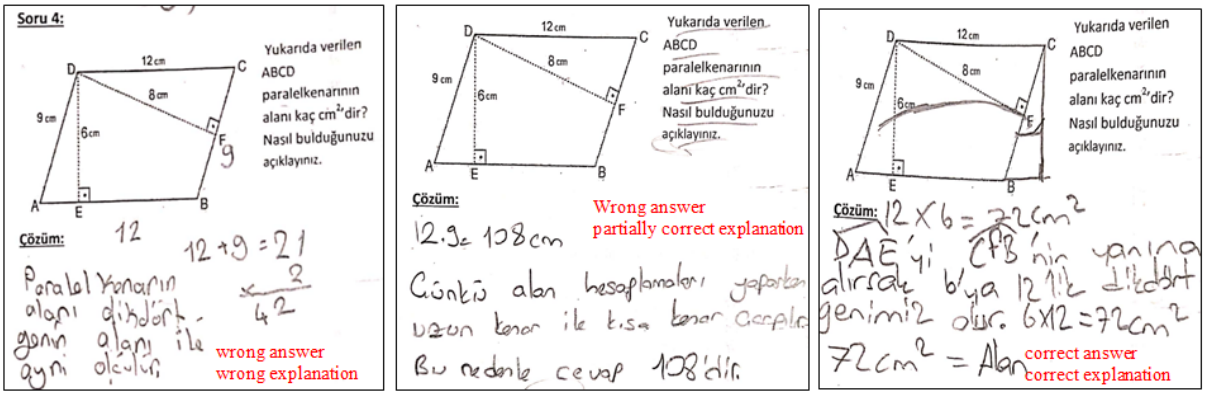
km^2, It is used in large areas. cm^2, It is used in small areas.

Figure 4 Student Answers to the Third Question

When the students' answers were examined, it was seen that the student in the first image did not know the sizes of the standard area measurement units. Although the students in the second and third images gave the correct answer, it was seen that the student in the second image reached the correct answer based on the standard length measurements. Since

the number of students who gave wrong answers to this question was relatively low, it was possible to say that, in general, students had information about the equivalents of standard area measurement units in daily life.

In the fourth research question, the students were asked to calculate the area of the parallelogram. Only 15% of the students gave the correct answer with the correct explanation, while 54% needed help to calculate the area of the parallelogram. Although 27% of the students gave wrong answers, they tried to calculate the area by showing a more accurate approach than the unsuccessful 54% group. Sample student answers are presented in Figure 5.



The area of a parallelogram is measured the same as the area of a rectangle.

Because when calculating the area, the long side is multiplied by the short side. Therefore, the answer is 108.

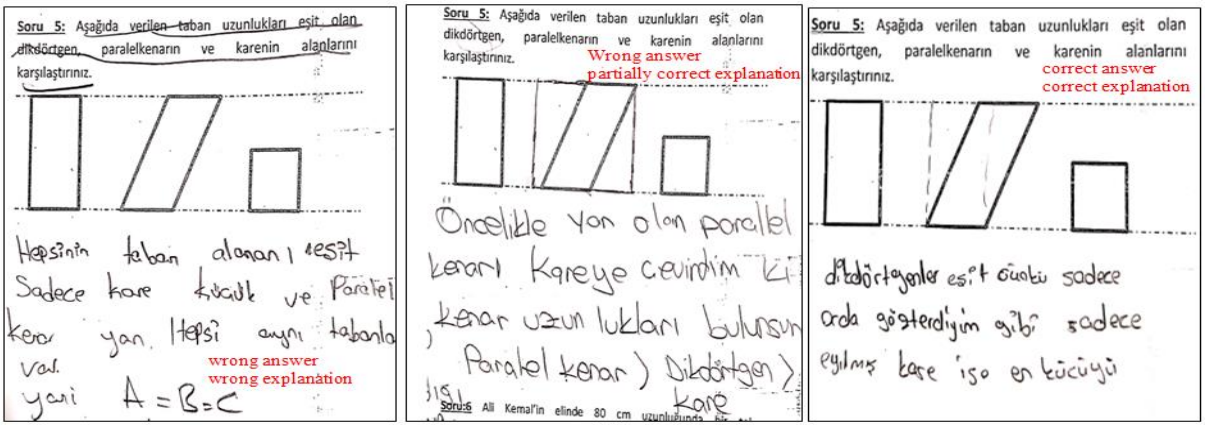
If we put the DAE triangle next to the CFB triangle, we have a 6 by 12 rectangle.

Figure 5. Student Answers to the Fourth Question

When the students' answers were examined, it was seen that the student in the first image confused the area of the parallelogram with its circumference and calculated the area with the circumference relation. In this way, students who confuse the area with the circumference and try to find the area in polygons by adding the side lengths constitute 27% (25 students) of the whole group. In the second image, the student calculated the area of the parallelogram as the product of the long and short sides and therefore answered the question incorrectly. Students calculating the area of a parallelogram as the product of its two sides constitute 27% of the group. In the last image, the student converted the parallelogram into a rectangle, calculated the area, and reached the correct answer.

The fifth question of the research was about area conservation and area relations. In total, 31% of the students gave the correct answer, 10% made a correct explanation, 16% made a partially correct explanation, and 15% gave an incomplete or incorrect explanation.

11% of the students gave a partially correct explanation with an incorrect answer, and 48% answered the question incorrectly with an incomplete or incorrect explanation. Sample student answers are presented below (Figure 6).



All of them have equal base area. Only the square is smaller, and the parallelogram is on its side. They all have the same base.

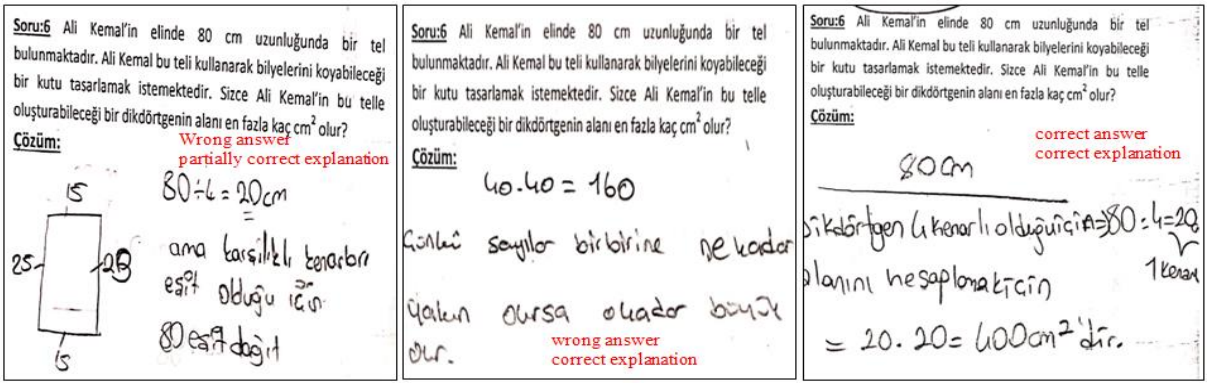
First of all, I turned the side parallelogram into a square to find the side lengths.
Parallelogram > rectangle > square

The rectangles are equal because it is just bent as I showed there, while the square is the smallest.

Figure 6. Student Answers to the Fifth Question

In the first image, the student should have paid more attention to the height while calculating the area, accepted the area of the three shapes as equal, and miscalculated the question. In the first image, the student made such a mistake because he did not know the mathematical equivalent of the area. Looking at the answer in the second image, it was seen that the student interpreted the areas after transforming the parallelogram into a familiar shape. However, while making this transformation, the student ignored the area conservation as in the third image and made a mistake by enlarging the shape from both sides. In the third image, the student transformed the parallelogram into a rectangle and reached the correct answer. Some students gave numerical values to all shapes and tried to find the answer. Students who gave the same values to parallelograms and rectangles with the same height (e.g. eight to the long side and four to the short side) calculated the area of both shapes as the product of the two sides and answered the question correctly. However, since the students made the mistake of calculating the area of the parallelogram as a rectangle, the students who found the correct answer to the question by calculating this way were coded in correct answer-partially correct explanation category. Students who found the correct answer to the question by calculating this way constitute 16% of the group. The findings obtained in this question coincided with the findings in the area of the parallelogram.

The sixth research question was within the scope of the circumference -length-area relationship, and it was determined as the question in which the students performed at the lowest level. The students who gave the correct answer with the correct explanation constituted only one percent of the group, the students who found the wrong answer and gave the correct explanation four percent of the group, and the students who could not give the correct answer but followed a partially correct solution formed 23% of the group. 71% of the group answered the question incorrectly. Sample student solutions are presented in Figure 7.



Since opposite sides are equal, distribute 80 equally.

Because the closer the numbers are to each other, the larger they are.

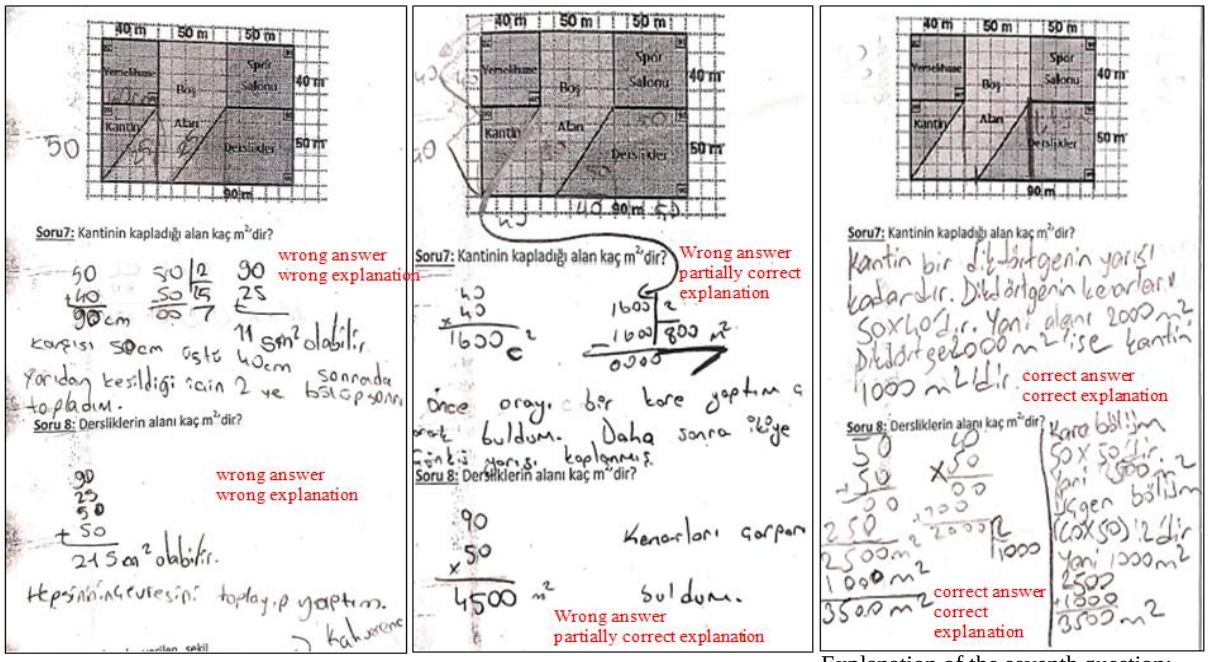
Since the rectangle has 4 sides, 80:4 = 20 cm (1 side) to calculate the area, 20 x20 = 400 cm^2

Figure 7. Student Answers to the Sixth Question

Figure 7 gives the answers of the students who followed the correct strategy. In the first image, the student showed a correct approach to finding the side lengths, but since the question asked for a rectangle, student tried to keep the opposite side lengths equal instead of all side lengths. The student did not accept the square as a rectangle. The students, who were in the wrong answer partly correct explanation category, tried to answer the question by giving values to complete the two side lengths to 80 and similar solutions. In the second image, the student made a correct explanation, valued the lengths of the two sides as 80, and found the wrong answer. In the third image, the student correctly explained and calculated the area. There was one student in the application group who gave the correct answer with the correct explanation. From this point of view, the students had difficulties and failed in this problem based on the area-circumference relationship.

The last two research questions were to determine student skills in determining areas of the triangle and trapezoid. Students who answered the seventh question correctly with a correct explanation were determined as 29% and 17% for the eighth question. While the students who made a correct explanation but gave a wrong answer were 3% for the seventh

question and 7% for the eighth question, Iin comparison, the students who gave a partially correct explanation with an incorrect answer were 16% for both questions. The students who answered the questions incorrectly, made wrong explanations, and did not explain were determined as 51% in the seventh and 60% in the eighth questions. Sample student answers to two questions are presented in Figure 8.



Explanation of the seventh question: The opposite side is 50 cm, the upper side is 40 cm, then since it was divided in half, I divided it by 2 and added it.
Explanation of the eighth question: I summed all circumferences

Explanation of the seventh question: First I made it a square, then I found it by multiplying. Then I divided it in half. Because it covered half of it.
Explanation of the eighth question: I found it by multiplying the sides.

Explanation of the seventh question: The canteen is half of a rectangle. The sides of the rectangle are 50x40. That is 2000 m^2. If the rectangle is 2000 m^2, the canteen is 1000 m^2.
Explanation of the eighth question: Square section is 50x50 = 2500 m^2. Triangular section (40 x50)/ 2. So it is 1000 m^2.

Figure 8. Student answers to the seventh and eighth questions

Looking at the student answers, the student who gave the wrong answer in the first image calculated the area of the right-angled triangle by adding the lengths of the right-angled sides and dividing it by two. The student, who made a mistake by adding the sides instead of multiplying the side lengths, calculated the circumference of the right-angled trapezoid instead of the area in the eighth question and expressed the result in area units. This student confused the area with the circumference. In the second image, the student calculated the area of the perpendicular triangle with the correct method but found an incorrect result because student determined the side lengths incorrectly. Student incorrectly calculated the right-angled trapezoid area by multiplying the side lengths. In the third image, the student correctly

calculated the area of both polygons and acted with the strategy of dividing and completing while calculating. Student found the area of the right-angled triangle by completing the rectangle in both questions. While calculating the area of the right-angled trapezoid, student divided the shape into more familiar shapes, such as triangles and rectangles. Students who calculated in this way constituted 17% of the whole group. Based on student answers, while calculating the area of triangles and trapezoids, students generally make calculations by completing or dividing the shape into a rectangle or square.

Discussions, Conclusions and Suggestions

This study examined middle school student's knowledge and skills in measuring areas. The results showed that the students had an overall unsuccessful performance in measuring area. While 35% of the students were in the unsuccessful category, the students in the excellent category made up two percent of the whole group. The evaluation based on questions determined that students' answers to all questions except the third question were concentrated on the "wrong answer-wrong explanation." In the study, a question was asked to the students, aiming to find the area of shapes that did not resemble the polygons they know, such as square, rectangle, and parallelogram, by counting the unit squares. However, most of the students had difficulty finding the area of the region by counting the unit squares, and it was determined that some students tried to calculate the area with the formula by completing the area to familiar rectangular and square shapes instead of counting the unit squares. While there was an easier way to find the area by counting the unit squares, the fact that the students tried to find the area with the formula brought to mind the idea that they did not know the concept of unit square or perceive the area as the amount occupied by a region. As Kamii and Kysh (2006) stated, students did not accept the unit square as a unit of area measurement. Olkun et al. (2014) stated in their study that students use formulas instead of calculating unit squares and area. The fact that these students thought of the area concept as two lengths multiplied rather than covering a region might be another reason for the results obtained. It is stated in studies that students limit the concept of area-to-area measurement (Çavuş Erdem, 2018; Huang & Witz, 2013). The main reason for this might be that the unit square was not emphasized much in the teaching of the subject, the teaching was formula-oriented, and the examples were presented on this axis because it was known that the problems arising from teaching and the teacher's lack of knowledge could be an essential factor in the students' mistakes in measuring area (Kidman & Cooper, 1997). Learning the concepts of area measurement with their mathematical properties correctly in studies is an effective method for

eliminating errors (Çavuş Erdem, 2018). Therefore, in order to prevent the limited perception of students, it would be a correct approach to create the perception that the area is covered with equivalent units, together with an understanding based on algorithms, and to transform it from column-row coordination to a systematic counting to multiplicative dimension (Clement & Stephan, 2004; Outhred & Mitchelmore, 2000).

Students' lack of understanding of unit squares, one of the basic concepts of area measurement, also affects their knowledge of standard area measurement units (Çavuş Erdem, 2018). Similarly, this study concluded that the students had deficiencies in standard area measurement units, and they made mistakes in the conversion between units. It was determined that the students divided the square centimeter by 1000 or 100 to convert the square meter, and some students wrote m and cm as the unit of measurement for the area. It is stated in the studies that students make mistakes in the transformations between units and have difficulties in terms of which number to multiply or divide by unit transformations (Doğan Çoşkun, 2017). Dealing with the relationship between units in an operational way is one of the main reasons for this situation (Bragg & Outhred, 2000). In textbooks, the transformation between units is made with a ladder analogy (Çağlayan et al., 2021). This method can cause students to convert by rote. In order to avoid such difficulties in transformations between units, it can be an effective method to show the size of the units and their relationship with each other through concrete objects (Olkun & Toluk Uçar, 2009). It can be suggested that unit squares such as m^2 and cm^2, which are large enough to be displayed in the classroom environment, should be shown with concrete materials, and the transformation should be explained through these materials. Thus, it can be ensured that students have an idea about the size of the units. In the study, it was determined that there was a group of 20% of students who had erroneous information about the size of the area measurement units. Most of the students had correct information about the sizes of standard unit squares. Students might have considered length measurement units when associating units of area measurement with examples in daily life. The statements "km is for the road, cm is less" in the students' answers supported this idea. Length measurement is the basis of area measurement, and for a correct understanding of area measurement, length measurement must also be understood correctly (Çetin, 2020; Outhred & Mitchelmore, 2000). The research results showed that this situation is also valid for measurement units.

In order to examine the area measurement skills of the students in the research, questions were asked to calculate the area of the parallelogram, triangle, and trapezoid. It was

observed that students made different mistakes while calculating. Some students added the side lengths to calculate the polygon area, while others mistakenly multiplied the two sides instead of the base and the height. The fact that the students added the side lengths showed that they confused the circumference and the area. In many studies, it is emphasized that students confuse the circumference and the area and similarly add the side lengths of the shapes to calculate the area (Baturo & Nason, 1996; Gelici, 2022; Simon & Blume, 1994; Smith, et al., 2016; Tan Şişman & Aksu, 2009). The fact that the area and the circumference were measurable properties of polygons, that both subjects were taught simultaneously, and that it was a formula-based teaching caused difficulties in this regard (Van De Walle et al., 2014). Another mistake identified by the students was that they multiplied the side lengths while calculating the area of the polygons. It could be argued that students made mistakes by overgeneralizing the area relation of square and rectangle (Schifter & Szymaszek, 2003). Students who were more successful in calculating the area of a rectangle had lower levels of success in calculating the area of a parallelogram, triangle, and trapezoid. Students were known to calculate the rectangle's area more easily (Gürefe, 2018). Baturo and Nason (1996) stated that students learned the area formula of the rectangle correctly without questioning why and how. In squares and rectangles, unlike other polygons, the height, which is the base and auxiliary element of the figure, is also the length of the side, which is the essential element of the figure. This situation could make the area calculation of rectangles and squares more memorable for students. At the same time, area calculation of rectangles and squares takes place before other polygons in the curriculum. The fact that it is the first subject that students encounter might also be another reason for the overgeneralization in area calculation. Another reason was that in calculating the area of this square and rectangle, the formula was expressed and taught as "the product of two sides" or "length × width" instead of "base x height." From this point of view, students might be mistaken as "the lengths of the sides are multiplied when calculating the area of polygons," this may cause the concept of area to be limited to the perception of "width x height." Kamii and Kysh (2006) stated that teaching with unit squares would be effective in preventing the limited perception of "width x height" in students. It could be effective to emphasize that the two lengths multiplied in the area formula of a rectangle, the base of the polygon and the height of that base, were also the two perpendicular sides of the polygon.

Another result obtained in the study about measuring area was that the students followed a strategy of dividing or completing into rectangles and squares while calculating the

area of triangles, parallelograms, and trapezoids. Gürefe (2018) similarly stated that students made calculations based on formulas in triangles and rectangles and follow multi-step strategies in parallelograms and trapezoids. In the field of teaching, the calculation of parallelograms, a calculation method based on rectangular conversion, was discussed (Çağlayan et al., 2021; Çetin, 2020). In the area formula of the triangle, the square and rectangle were similarly used when explaining the reason for dividing into two. This result was thought to be due to education.

In the study, students had difficulty calculating the area of a polygon given its perimeter. Similarly, Orhan (2013) stated in his study that students had difficulty in finding the perimeter of a polygon whose area was given, while Çelik (2023) stated that while students were trying to create rectangles with equal and different areas, they could not establish a relationship depending on the size of the unit. Chappell and Thompson (1999) stated that students thought polygons with the same area would have the same perimeter. The area and circumference mentioned above could confuse students (Gelici, 2022), and not making the correct association between the area and the environment caused difficulties (Martin & Strutchens, 2000). How students interpreted the relationship between the side length and the area was also essential. Because students might think there was a linear relationship between the side length and the area and between the circumference and the area (Çavuş Erdem, 2018; Moreira & Content, 1997), this thinking also led to errors. One of the main reasons students made such mistakes was that formulas were handled operationally without being conceptually understood because correctly using the area formula did not mean that the concept of area was learned (Fauzan, 2002). The fact that there were students who correctly calculated the area of the rectangle but could not calculate the area of the shape given the circumference supported this idea.

Regarding this question, it was also determined that some students stated that the square was not a rectangle. Studies involving students who did not accept the square as a particular form of rectangle emphasized that this situation might have cognitive and pedagogical origins (Monaghan, 2000). Studies showing that teacher candidates had similar perceptions (Horzum, 2018) strengthened the possibility that this misconception in students stemmed from teaching.

In summary, in this study, it was determined that students had difficulties in transforming units, and they were more successful in calculating the area of a rectangle than in calculating the area of a parallelogram, triangle, or trapezoid. Students who calculated the area using unit squares covering a region was the majority. However, students who did not

use unit squares in calculating the area made up one-third of the group. Other results obtained from the research were that students tended to multiply the two sides of the polygon while measuring area and that some students confused area measurement with circumference measurement. Not learning the area conceptually and formula-based teaching were the main reasons for these mistakes. In teaching the subject, emphasizing that the area is the amount that covers a region and the role of the unit square in determining this amount, then switching from the counting form to the multiplicative form, which is a shorter way, thus creating area relations, would support students' correct learning and improve their area measurement skills. There may be other factors that are effective in the occurrence of detected errors. It was recommended to conduct research with different student groups to reveal these factors that cause errors in epistemological, pedagogical, or psychological dimensions.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

Funding

None.

CRediT author statement

The study was single authored and the whole process was carried out by the corresponding author

Research involving Human Participants and/or Animals

The study involves human participants. The author signed the declaration stating that there was no need for ethics committee approval and submitted it to the journal because the manuscript is a study produced from the data gathering before 2020.

Ortaokul Öğrencilerinin Alan Ölçme Bilgi ve Becerilerinin İncelenmesi

Özet:

Bu çalışmada, ortaokul öğrencilerinin alan ölçme bilgi ve becerilerinin incelenmesi amaçlanmıştır. Betimsel yöntemin kullanıldığı araştırmada veriler, yedinci sınıfta öğrenim gören 92 öğrenciden, 8 adet açık uçlu soru ile yazılı olarak toplanmıştır. Öğrencilerin cevapları açık uçlu soruları puanlama ölçeği ile analiz edilmiştir. Araştırmada, alan ölçme birimlerinin büyüklüğünü doğru bir şekilde tahmin eden öğrencilerin çoğunlukta olduğu, fakat standart alan ölçme birimlerinin dönüşümünde zorlandıklarını göstermektedir. Alanı, bir bölgeyi kaplayan birim karelerin sayısı olarak hesaplayabilen öğrenciler çoğunluktadır. Dikdörtgenin alanını ölçmede başarılı olan öğrencilerin, paralelkenar, üçgen ve yamuğun alanını ölçmedeki başarısı düşük olarak belirlenmiş ve öğrencilerin alan ölçerken çokgenin iki kenarını çarpmaya meyilli oldukları gözlenmiştir. Ayrıca bazı öğrencilerin alanı çevre ile karıştırdıkları belirlenmiştir.

Anahtar kelimeler: alan ölçme, alan ölçme becerisi, geometri öğretimi, ortaokul öğrencileri.

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Research Article

Examination of Secondary School Mathematics Teachers' Digital Literacy Self-Efficacy, E-learning Readiness, Technology Acceptance Levels, and Attitudes Towards Distance Education*

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Abstract – In this study, digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes toward distance education of secondary school mathematics teachers were examined during the pandemic process. 108 secondary school mathematics teachers working in Uşak province and its districts, selected by convenience sampling method, participated in the study. Personal information forms, "Digital Literacy Self-Efficacy Scale", "E-learning Readiness Scale", "Technology Acceptance Scale for Teachers" and "Attitude Towards Distance Education Scale" were used as data collection tools. Descriptive statistics, t-tests for relational samples, one-factor analysis of variance, and multiple correlation analysis were used for data analysis. The study concluded that secondary school mathematics teachers' digital literacy self-efficacy levels, e-learning readiness levels and technology acceptance levels were at high level and their attitudes towards distance education were at medium level. It was determined that there was positive and high-level relationship between secondary school mathematics teachers' digital literacy self-efficacy and their readiness for e-learning, positive and medium-level relationship between their technology acceptance levels, and negative and low-level relationship between their attitudes towards distance education. In addition, it was determined that there was a moderate positive relationship between their e-learning readiness and technology acceptance, while there was a low positive relationship between their attitudes towards distance education.

Key words: Digital Literacy Self-Efficacy, Attitudes Towards Distance Education, Mathematics Teachers, E-learning Readiness, Technology Acceptance.

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Introduction

Technology has started to be used in every field with the development and spread of technology. International competition as a consequence of technological developments has also changed the qualifications expected by countries from individuals (Eruysal Sertbarut, 2021). The development of fingerprint and face recognition technologies, the use of unmanned aerial vehicles and drones in several fields, the use of tools developed with chip technologies, and the use of artificial intelligence and robots have changed our understanding of daily life. Now, qualified individuals who can produce and use technology rather than manpower are needed. The individuals are now expected to have some qualifications called 21st-century skills along with school diplomas and basic skills to find a job in the 21st century (Uluyol & Eryılmaz, 2015). To instill these skills, the Partnership for 21st Century Learning (P21) framework, also known as the 21st Century Skills Framework Partnership was developed (Gelen, 2017; P21, 2018). This framework was created for the first time in 2006 with businesses such as Microsoft, Apple, America Online (AOL), etc., and educational societies such as National Education Association (NEA) under the leadership of the United States of America (USA) Ministry of Education, and then continued with changes. This framework was created to ensure the integration of 21st-century skills into education (Kurudayıoğlu & Soysal, 2018). The P21 framework enables individuals to have a good working and daily life via a variety of learning resources and aids them to be ready for the qualifications required by the 21st century (P21, 2018). Individuals with 21st-century skills are individuals who can shape their lives, keep up with the changes in their lives, and develop themselves in pursuing a career and advancement. In addition, individuals who can look at the events around them critically, produce solutions to the encountered problems, have good communication with their environment and work in cooperation, make a difference with their creativity, and use information and communication technologies correctly and reliably can stand out in the 21st century (P21, 2018). In this period of digitalization of life, the importance of the technology dimension of the 21st century skills is also increasing. In Turkey, as in the world, there is a need for teachers who are open to development and follow innovations and developments for the integration of technology and scientific developments with education, the ability to catch these developments well by students, and rendering education more efficient (Aksoy et al., 2021). Teachers are required to be able to access reliable and correct e-content that is suitable for the outcomes, to shape this content in accordance with the technological equipment available in the school and the classrooms, and

to apply the content complying with a certain plan in the classroom considering the level of the students. In addition, they are expected to use the internet correctly and reliably and to be able to transfer the content to their students. The access and use of technology, digital tools, and equipment as well as their integration into the course can only be possible with a certain technological knowledge of teachers. The concept of digital literacy emerges in this process. Digital literacy is a concept encompassing some 21st-century skills that include correct and target-oriented use of digital resources. The concept of digital literacy, which was first introduced by Gilster (1997), was defined as accessing, using, and expressing information in different ways with the help of digital resources. In other words, digital literacy means correct and target-oriented use of digital equipment, reaching the desired information through digital resources, converting this information into different forms, and using the same in the desired way (Terzi & İşli, 2020). Briefly, digital literacy can be explained as reaching the goal by correct and target-oriented use of digital resources. Under today's conditions, individuals are expected to have digital competences to keep up with life and do their jobs. Teachers and students should keep up with these technological changes for the acquisition of the desired information and the appropriate use of the same (Doğan & Birişçi, 2022). It is hence important for students to have a certain level of digital literacy in order to keep up with this change. Therefore, teachers are expected to develop their digital literacy and guide students as well.

Being an important part of education, teachers are under the influence of technological changes and try to benefit from these changes in the education-teaching process (Yılmaz & Toker, 2022). Appropriate trainings should be taken for the application of these technologies in the classrooms. In order to achieve this, the use and application of technology by enhancing technological opportunities in e-learning and the acceptance of technology have become important (Binay-Eyuboğlu & Karaoğlan-Yılmaz, 2018). This is where technology acceptance becomes significant. There have been studies on technology acceptance from the past to the present. Initially, the Technology Acceptance Model was developed by Davis et al. (1989). In another study, the Technology Acceptance and Use Model was developed by Venkatesh et al. (2003) by combining 8 different technology models. This model was developed by Venkatesh et al. (2012) and the Unified Theory of Acceptance and Use of Technology Model 2 was proposed. In this way, models were developed, and technology acceptance was attempted to be explained. Considering teachers' acceptance of technology, teachers' age, experience, technology knowledge, and self-confidence towards technology are

thought to affect the acceptance of technology and its adaptation to courses (Aktürk & Delen, 2020).

While the importance of technology acceptance was examined by various studies, the necessity of technology came to the fore once again with the COVID-19 pandemic, which emerged in China in 2019 and spread to the world in a short time. There have been changes in our lives in fields such as education, sociality, economy, etc. in the world and in our country. In our country, curfews, transportation restrictions, quarantines, and educational changes have been the main measures taken to protect from the effects of the pandemic (Kavuk & Demirtaş, 2021). In our country, face-to-face education was suspended in all schools affiliated with the Ministry of National Education on March 12, 2020, and for the entire semester at universities on March 16, 2020. With the suspension of face-to-face education, there has been an urgent transition to distance education. With this sudden development, teachers have been in search for the continuation of education. Despite this unusual situation, teachers have made an effort to continue education and training by teaching their courses with remote meeting applications such as social media tools, Zoom, Google Meets, etc., or by shooting course videos and sharing them with their students. Meanwhile, the Ministry of National Education made an urgent move to continue education and training by creating TRT EBA channels on television. In addition, live courses and distance education courses were tried in the determined pilot provinces, and 8th and 12th grades preparing for exams were taught by distance education (MoNE, 2020).

Teachers' e-learning readiness was felt most during this period. In addition, teachers' e-learning readiness is closely related to the effectiveness of education (Geniş, 2022; Hukle, 2009). E-learning readiness is the ability of individuals to effectively use e-learning technologies in order to increase the quality of education (Kaur & Abbas, 2004). Another definition includes an individual's ability to use e-learning technologies, motivation, attitude, belief, and self-efficacy towards e-learning (Baygeldi et al., 2021; Zor, 2021). A general readiness study should be conducted to reduce failures in e-learning and ensure a successful education (Demir Öztürk & Eren, 2021; Mercado, 2008). It is important to particularly examine the readiness of teachers for e-learning and to identify and correct the deficiencies (Geniş, 2022).

There are many factors in the success of distance education during the pandemic period (Koca & Tutal, 2021). The restrictions experienced by the teachers who play a crucial role in the conduct of the lessons during the pandemic, the internet infrastructure in the region, the

devices they own, and their attitudes towards distance education can create a disadvantage for distance education (Dönmez et al., 2022). One of the most important factors is teachers' attitudes towards distance education (Ağır et al., 2007). Examining the attitudes of teachers based on their experiences on distance education is important for future distance education activities.

With the transition to distance education during the Covid-19, students had difficulty adapting to this system. The mathematics course was especially one of the most difficult courses for students (İnci, 2021). The unique nature, concepts, symbols, and abstractness of mathematics, the interconnectedness of subjects, and the inability of students to attend the lessons caused this difficulty. Furthermore, teachers experienced problems due to the lack of use of technological equipment, inexperience in distance education, inability to reach appropriate materials, and absenteeism of students (Özdemir Baki & Çelik, 2021). As can be understood from the process, it is considered important for mathematics teachers to adopt and use digital literacy and technology for education.

Considering the developments experienced today, the changes brought by the pandemic have increased the use of technology. Especially the introduction of distance education into education life has increased the importance of e-learning. In our country, e-learning has previously been used as well. Some departments of universities continued their education with e-learning (Akdemir, 2011). In addition, various in-service trainings of teachers were also carried out through e-learning (Gebel & Tekin Bozkurt, 2022). During e-learning, teachers and students may experience problems in terms of hardware and learning. Given this context, some problems were experienced during the complete transition to distance education with the pandemic. Some problems such as the lack of adequate equipment, the inability to ensure attendance in distance education, and the ineffectiveness of distance education compared to face-to-face education have shown the improvement-requiring aspects of distance education (Baloğlu & Fırat, 2022). It is considered that making education effective is related to teachers' e-learning competences. The level of preparedness of teachers for e-learning, their e-learning readiness, and their self-development in this direction are considered important for distance education. With the continuation of the pandemic, people have started to make their lives easier by using technological opportunities. While seeking scenarios of retransition to face-to-face education, distance education also continued. In this process, educational technologies have also developed and provided opportunities for education to be enriched in terms of digital content. The frequency of teachers' use of technology here can

change the course of their lessons. Many factors such as the teacher's age, distance education experiences, self-efficacy in teaching, and perception of technology affect their willingness to use technology and adapt it to their courses (Aktürk & Delen, 2020). The attitudes of the teachers involved in this process towards distance education are also considered important. It is thought that it is necessary to determine the attitudes of teachers towards distance education in terms of the efficiency of distance education and its use in the future. In the distance education process, the mathematics course has been the most challenging course for secondary school students (Karataş, 2020). From the perspectives of teachers, the abstract language of mathematics, the difficulty of using mathematical concepts and symbols in distance education, and the absenteeism of students despite the interconnectedness of mathematics subjects made mathematics education more difficult for students as well as teachers (Özdemir Baki & Çelik, 2021). On the other hand, the lack of adequate hardware knowledge of teachers about distance education, the inability to access adequate materials, the concern about not completing subjects, and the lack of experience caused difficulties and disruptions in the distance education process (Özdemir Baki & Çelik, 2021). It is thought that there is a need for teachers who have the vision of educating well-equipped students in terms of 21st-century skills, use technology effectively, and have the ability to integrate it into the teaching process. The effective face-to-face, hybrid, and distance teaching of mathematics, which is known to be difficult to learn, is related to the competences of teachers (Coşkun Şimşek et al., 2022). In this direction, it is considered important to shed light on the mathematics teaching process during the pandemic, to be prepared for new emergency distance education situations, and to examine the teachers in terms of the factors that will affect distance education in the process of urgently planning the necessary precautions and measures. In this direction, the aim of the study is to examine the digital literacy self-efficacy, e-learning readiness, technology acceptance level, and attitudes towards distance education of secondary school mathematics teachers in terms of various variables and to examine the correlation between their technology acceptance levels, digital literacy self-efficacy, e-learning readiness, and attitudes towards distance education during the pandemic.

The problems determined in line with the purpose of the study are as follows:

1. How are secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education during the pandemic?

2. Do the secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education differentiate according to various variables (gender, professional seniority, and distance education status) during the pandemic?

3. Is there a significant correlation between secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education during the pandemic?

Method

Research Design

This study was based on the correlational screening model. The correlational screening model is a screening approach that aims to determine the existence of covariance between two or more variables. In the correlational screening model, it is tried to determine whether the variables change together and if there is a change, how it happened (Karasar, 2011). The independent variables are gender, seniority, and educational status related to distance education while the dependent variables are digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education. In the study, the correlational screening model was used since it was aimed to examine the digital literacy self-efficacy, e-learning readiness, technology acceptance level, and attitudes towards distance education of secondary school mathematics teachers with respect to various variables during the pandemic.

Participants

The study was carried out with 108 secondary school mathematics teachers selected by convenience sampling method, working in secondary schools affiliated with the Ministry of National Education in the province and districts of Uşak in 2021. It is a method that aims to prevent the loss of time, money, and labor in an appropriate sampling method (Büyüköztürk et al., 2015). The gender, educational status, and seniority distribution of the teachers in the study group are presented in Table 1.

Table 1 Secondary School Mathematics Teachers' Gender, Educational Status, and Professional Seniority Variables

	Gender	f	%
Gender	Female	74	68.52
	Male	34	31.48
Educational Status	Undergraduate	88	81.48
	Graduate	20	18.52
	PhD	-	-
Professional Title	0-5 Years	49	45.37
	6-10 Years	30	27.78
	11-15 Years	12	11.11
	16-20 Years	10	9.26
	21-25 Years	7	6.48
Total		108	100

On examination of Table 1, 74 (68.52%) of the teachers participating in the study were female, 34 (31.48%) were male; 88 (81.48) were at the undergraduate level and 20 (18.52%) at the graduate level. In addition, 49 (45.37%) were determined to have professional seniority between 0-5 years, 30 (27.78%) between 6-10 years, 12 (11.11%) between 11-15 years, 10 (9.26%) between 16-20 years, and 7 (6.48%) between 21-25 years.

Data Collection Tools

A personal information form was created in order to determine some demographic characteristics of secondary school mathematics teachers participating in the study. In this scope, questions were asked in order to obtain the data relating to teachers' demographic information (gender, education level, professional seniority year, status of having a personal computer, internet access status, main purpose of using the internet, the means of participation in distance education, status of receiving training related to distance education, the equipment they use in the distance education process). The "Digital Literacy Self-Efficacy Scale" (DLSS) developed by Karakuş and Ocak (2018) was used to measure teachers' digital literacy self-efficacy. The scale consists of 4 dimensions: "production, ability to use resources, ability to use applications, and support". The first dimension of the scale (production) consists of 11 items, the second dimension of the scale (ability to use resources) consists of 10 items, the third dimension of the scale (ability to use applications) consists of 9 items, and the fourth dimension of the scale (support) consists of 5 items. As a result of the reliability analyses regarding the sub-dimensions and the whole scale calculated during the development process of the scale used in the study, Cronbach's Alpha values were calculated as 0.90 for the first factor, 0.88 for the second factor, 0.86 for the third factor, 0.81 for the fourth factor, and 0.96 for the whole scale. In order to determine the teachers' e-learning readiness, the "E-Learning

Readiness Scale (E-LRS)" developed by Yurdagül and Demir (2015) was used. The scale consists of 4 dimensions. These dimensions are "ICT use self-efficacy", "self-confidence in e-learning", "attitude towards e-learning", and "training needs for e-learning". As a result of the reliability analyses of the entire scale, Cronbach Alpha values were calculated as 0.89 for ICT use self-efficacy, 0.92 for self-confidence in e-learning, 0.94 for attitude towards e-learning, 0.83 for training need for e-learning, and 0.92 for the entire scale. "Scale of Technology Acceptance of Teachers: T-TAS" developed by Ursavaş et al. (2014) was used to determine teachers' technology acceptance levels. As a result of the reliability analyses regarding the sub-dimensions and the whole scale calculated during the development process of the scale, Cronbach Alpha values were calculated as 0.901 for "perceived usefulness", 0.908 for "perceived ease of use", 0.894 for "attitude towards use", 0.896 for "behavioral intention", and "facilitating situations". 0.811 for "perceived joy", 0.798 for "self-efficacy", 0.856 for "technological complexity", 0.822 for "suitability", 0.869 for "concern", 0.835 for "subjective norm", and 0.864 for the entire scale. In order to determine the attitudes of teachers towards distance education, the "Distance Education Attitude Scale (DEAT)" developed by Ağır et al. (2007) was used. The Cronbach Alpha value of the scale was 0.835. Ethics committee approval was applied during the study, and it was approved with the ethics committee permission document dated 18.11.2021 and numbered E-19928322-302.08.01-87821 that there was no violation of research ethics.

Data Analysis

Statistical analysis package program (IBM SPSS Statistics 26) was used to analyze the data obtained in the study. Descriptive statistics were used in order to determine the distributions of the DLSS, E-LRS, T-TAS, and DEAT scores. The scores of the secondary school mathematics teachers participating in the study were calculated to determine the type of analysis to be used in the study and the skewness and kurtosis values were examined to determine the normality of the scores according to the independent variables. In addition, the Shapiro-Wilk test was used to determine the normality of the data. Table 2 presents the Shapiro-Wilk test results, skewness, and kurtosis values of the teachers' DLSS, E-LRS, T-TAS, and DEAT scores and Shapiro-Wilk test results, skewness, and kurtosis values according to the variables of gender, professional seniority, and distance education status.

Table 2 Normality Results of The DLSS, E-LRS, T-TAS, and DEAT Scores According to Gender, Seniority, and Distance Education Variables

Scales	Variables		Shapiro-Wilk Value	Skewness	Kurtosis
DLSS	Scale		.18	-.36	.36
	Gender	Female	.40	-.15	-.40
		Male	.23	-.47	.68
	Seniority	0-5	.59	-.12	.34
		6-10	.38	-.57	.49
		11-15	.91	.49	-.12
		16-20	.68	.11	-1.13
		21-25	.69	-.31	1.08
	Distance education status	Yes	.53	.19	-.64
		No	.37	-.37	.24
E-LRS	Scale		.24	-.32	.41
	Gender	Female	.11	-.35	-.34
		Male	.25	-.42	1.32
	Seniority	0-5	.07	-.69	.32
		6-10	.45	.72	1.12
		11-15	.67	-.52	.00
		16-20	.23	-.33	-.75
		21-25	.45	.12	-1.77
	Distance education status	Yes	.53	.19	-.64
		No	.37	-.37	.24
T-TAS	Scale		.40	-.33	.45
	Gender	Female	.73	-.10	-.17
		Male	.35	-.74	1.19
	Seniority	0-5	.07	-.49	-.41
		6-10	.31	-.40	.48
		11-15	.78	.36	-.38
		16-20	.67	-.19	.51
		21-25	.58	-.19	.12
	Distance education status	Yes	.75	.07	-.32
		No	.28	-.46	.54
DEAT	Scale		.12	-.35	.84
	Gender	Female	.03	-.55	1.44
		Male	.47	-.03	-.38
	Seniority	0-5	.00	-1.01	1.22
		6-10	.94	-.20	.61
		11-15	.59	.45	-.83
		16-20	.27	1.06	1.76
		21-25	.63	.56	.34
	Distance education status	Yes	.19	-.54	1.08
		No	.82	-.03	-.20

The data was assumed to have a normal distribution if kurtosis and skewness values were between -1.5 and +1.5 according to Tabachnick and Fidell (2013) and between -2.0 and +2.0 according to George and Mallery (2010). Accordingly, on examination of the data in Table 2, the data obtained from the scales showed a normal distribution in terms of seniority,

gender, and distance education variables. In addition, it was observed that the p-value obtained from the Shapiro-Wilk test did not (extremely) deviate from the normal distribution of the scores at the significance level of α=.05. Due to the normal distribution of the data, a t-test for unrelated samples was used to determine whether secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and distance education attitude scores differ according to gender and distance education status; and one-way analysis of variance for unrelated samples to determine whether they differ according to the variable of professional seniority. In addition, the score ranges of secondary school mathematics teachers from the scales of DLSS, E-LRS, T-TAS, and DEAT were evaluated. If the ranking measurement level can be ranked in terms of having a certain feature, this ranking can be defined as the measurement level. Accordingly, for five-point Likert-type scales and their sub-dimensions, the mean ranges of 1-2.33 was accepted low, 2.34-3.66 moderate, and 3.67-5 high; and for the seven-point Likert scale, 1-2.99 was accepted low, 3-5 moderate and 5.01-7 high. In addition, a multi-correlation analysis was conducted to determine the correlation between the scores obtained from secondary school mathematics teachers' technology acceptance levels, digital literacy self-efficacy, e-learning readiness, and attitudes towards distance education.

Findings and Discussions

From the responses to the first question of the study "Do the secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education differentiate according to various variables during the pandemic?", descriptive statistics of the teachers' DLSS, E-LRS, T-TAS, and DEAT scores were calculated. Descriptive statistics are given in Table 3.

Table 3 Descriptive Statistics of DLSS, E-LRS, T-TAS, and DEAT Scores

Scales	f	Minimum	Maximum	$\bar{X}$	S
DLSS	108	2.69	4.82	3.71	.65
E-LRS	108	2.85	6.36	5.07	.64
T-TAS	108	2.20	4.19	3.63	.47
DEAT	108	1.93	4.28	3.32	.24

On examination of Table 3, the mean score of the DLSS was seen as $\overline{X}$ =3.71. According to the scaling specified in the data analysis section of this score, the digital literacy self-efficacy of secondary school mathematics teachers can be interpreted at a "high" level. The mean score of the E-LRS was seen as $\overline{X}$ =5.07. According to the scaling specified in the

data analysis section of this score, the e-learning readiness of secondary school mathematics teachers can be interpreted at a "high" level. The mean score of the T-TAS was seen as $\overline{X}$ =3.63. According to the scaling specified in the data analysis section of this score, the technology acceptance levels of secondary school mathematics teachers can be interpreted at a "moderate" level. The mean score of the DEAT was seen as $\overline{X}$ =3.32. According to the scaling specified in the data analysis section of this score, the attitudes of secondary school mathematics teachers to distance education were determined to be at a "moderate" level.

On item-by-item examination of the answers given by the teachers to the DLSS, the item "I can establish a group where I can communicate with students or parents (for example, a Whatsapp group)" was marked by the highest number of people with an average of 4.82 points. Accordingly, the teachers' ability to establish a communication environment with students and parents can be interpreted to be at a high level. The item "I can create an educational blog" in DLSS was marked by the least number of people with an average of 2.69 points. Accordingly, the teachers' skills in preparing blogs for educational purposes were determined to be at a moderate level.

On item-by-item examination of the answers given by the teachers to the E-LRS, the item "I can use search engines (Google, Yandex search, etc.) confidently" was marked by the highest number of people with an average of 6.36 points. Accordingly, the teachers' ability to use search engines effectively can be interpreted to be at a high level. The item "I think I will be nervous while teaching through e-learning" was marked by the least number of people with an average of 2.85 points. Accordingly, the anxiety levels of the teachers while teaching through e-learning were determined to be at a moderate level.

On item-by-item examination of the answers given by the teachers to the T-TAS, the item "Using ICT makes the lesson more enjoyable and interesting" was marked by the highest number of people with an average of 4.19 points. Accordingly, the teachers' thought that ICT use makes the lessons fun and enjoyable can be interpreted to be at a high level. The item "Using new technologies has always been complicated for me" was marked by the least number of people with an average of 2.20 points. Accordingly, the teachers' thought of finding new technologies complicated was determined to be at a low level.

On item-by-item examination of the answers given by the teachers to the DEAT, the item "Face-to-face education is more useful than distance education" was marked by the highest number of people with an average of 4.28 points. Accordingly, the teachers' opinion

of finding face-to-face education more useful than distance education can be interpreted to be at a high level. The item "Face-to-face education is more effective than distance education" in DEAT was marked by the least number of people with an average of 1.93 points. Accordingly, the teachers' opinion of finding distance education more effective than face-to-face education was determined to be at a low level.

From the responses to the second question of the study "Do the secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education differentiate according to various variables (gender, professional seniority, and distance education status) during the pandemic?" DLSS, E-LRS, T-TAS, and DEAT scores by independent variables were examined. Due to the normal distribution of the data, a t-test for unrelated samples was used to determine whether they differed according to gender and distance education status variables. The t-test results for the unrelated samples are presented in Table 4.

Table 4 T-test Results of the DLSS, E-LRS, T-TAS, And DEAT Scores According to Various Variables

Scales	Variables		N	$\bar{X}$	S	sd	t	p
DLSS	Gender	Female	74	3.75	.59	106	.87	.15
		Male	34	3.63	.76			
	Distance Education Status	Yes	36	3.87	.54	106	1.85	.13
		No	72	3.63	.68			
E-LRS	Gender	Female	74	3.52	.91	106	-1.02	.68
		Male	34	5.03	.60			
	Distance Education Status	Yes	36	5.16	.65	106	1.01	.29
		No	72	5.03	.64			
T-TAS	Gender	Female	74	3.60	.43	106	-1.01	.23
		Male	34	3.70	.55			
	Distance Education Status	Yes	36	3.77	.44	106	2.21	.74
		No	72	3.56	.47			
DEAT	Gender	Female	74	3.29	.23	106	-1.34	.67
		Male	34	3.36	.24			
	Distance Education Status	Yes	36	3.30	.29	106	-.42	.12
		No	72	3.32	.21			

On examination of Table 4, the average of the male participants' E-LRS, T-TAS, and DEAT scores can be said to be higher than the average of the female participants' scores. On examination of the t-test results for unrelated samples performed to determine the significance of the observed difference, it can be seen that female and male participants' E-LRS mean scores [t(106)= -1.02, p>.05], T-TAS mean scores [t (106)= -1.01, p>.05], and DEAT mean

scores [t (106)= -1.34, p>.05] do not differ significantly. On the other hand, the mean scores of the female participants can be said to be higher than the mean scores of the male participants. On examination of the t-test results for unrelated samples performed to determine the significance of the observed difference, it can be seen that female and male participants' DLSS mean scores [t (106)=.87, p>.05] do not differ significantly. With these results, no statistically significant correlation was determined between the DLSS, E-LRS, T-TAS, and DEAT scores and gender.

On examination of Table 4, the mean scores of the participants who received training on distance education can be said to be higher than the mean scores of the participants who did not receive training on distance education. On examination of the t-test results for unrelated samples performed to determine the significance of the observed difference, it can be seen that DLSS mean scores [t(106)=1.85, p>.05], E-LRS mean scores [t(106)=1.01, p>.05], and T-TAS mean scores [t(106)=2.21, p>.05] of participants who received and did not receive training on distance education do not differ significantly. The DEAT mean scores of the participants who did not receive training in distance education can be said to be higher than the mean scores of the participants who received training in distance education. On examination of the t-test results for unrelated samples performed to determine the significance of the observed difference, it can be seen that DEAT mean scores [t(106)=-.42, p>.05] of participants who received or did not receive training on distance education do not differ significantly. These results can be interpreted as the absence of a statistically significant correlation between the scores of DLSS, E-LRS, T-TAS, and DEAT and the status of receiving distance education (Büyüköztürk, 2020).

In order to seek an answer to the second question of the study, the teachers' scores of DLSS, E-LRS, T-TAS, and DEAT were also examined according to the variable of professional seniority. The distributions of the teachers' scores of DLSS, E-LRS, T-TAS, and DEAT according to these variables are given in Table 5.

Table 5 Distribution of Secondary School Mathematics Teachers' DLSS, E-LRS, T-TAS, and DEAT Scores According to Professional Seniority Variable

Scales	Professional Title	N	$\bar{X}$	S
DLSS	0-5	49	3.77	.62
	6-10	30	3.62	.74
	11-15	12	3.67	.41
	16-20	10	3.44	.73
	21-25	7	4.15	.45
	Total	108	3.71	.65

E-LRS	0-5	49	5.03	.64
	6-10	30	5.13	.62
	11-15	12	5.03	.56
	16-20	10	4.84	.85
	21-25	7	5.50	.51
	Total	108	5.07	.64
T-TAS	0-5	49	3.64	.39
	6-10	30	3.68	.59
	11-15	12	3.54	.46
	16-20	10	3.47	.56
	21-25	7	3.70	.26
	Total	108	3.63	.47
DEAT	0-5	49	3.27	.24
	6-10	30	3.41	.24
	11-15	12	3.32	.23
	16-20	10	3.25	.18
	21-25	7	3.33	.23
	Total	108	3.32	.24

On examination of Table 5, it can be seen that the DLSS, E-LRS, T-TAS, and DEAT scores of the participants differ according to the variables of professional seniority. ANOVA test was performed to test the statistical significance of the differences seen in the participants' DLSS, E-LRS, T-TAS, and DEAT scores. The results of the ANOVA test are given in Table 6.

Table 6 ANOVA Results of DLSS, E-LRS, T-TAS, and DEAT Scores by Professional Seniority

Scales		Sum of Squares	sd	Mean of Squares	F	p
DLSS	Intergroup	2.47	4	.62	1.51	.20
	Intragroup	42.08	103	.41		
	Total	44.55	107			
E-LRS	Intergroup	2.02	4	.50	1.22	.31
	Intragroup	42.38	103	.41		
	Total	44.39	107			
T-TAS	Intergroup	.49	4	.12	.55	.70
	Intragroup	22.91	103	.22		
	Total	23.40	107			
DEAT	Intergroup	.44	4	.11	2.04	.09
	Intragroup	5.59	103	.05		
	Total	6.03	107			

On examination of Table 6, it is seen that DLSS [F(4,103)=1.51, p>.05], E-LRS [F(4,103)=1.22, p>.05], T-TAS [F(4,103)=.55, p>.05], and DEAT [F(4,103)=2.04, p>.05] mean scores do not differ significantly according to the professional seniority.

From the responses to the third question of the study "Is there a significant correlation between secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education during the pandemic?", the Pearson correlation coefficient between the DLSS, E-LRS, T-TAS, and DEAT scores were examined. The results of the correlation analysis are given in Table 7.

Table 7 Correlation Analysis Results

Scales	DLSS	E-LRS	T-TAS	DEAT
DLSS	1	.71	.36	-.01
E-LRS		1	.45	.03
T-TAS			1	.19
DLSS				1

On examination of Table 7, while a positive and high correlation was determined between secondary school mathematics teachers' digital literacy self-efficacy and their e-learning readiness ($r = .71$), a moderate positive correlation was determined between their technology acceptance levels, and a low negative correlation between their attitudes towards distance education ($r =. -.01$). In other words, it can be said that as secondary school mathematics teachers' digital literacy self-efficacy increases, their e-learning readiness and technology acceptance levels increase, while their attitudes towards distance education decrease. While a moderate positive correlation was determined between e-learning readiness and technology acceptance ($r = .45$) of secondary school mathematics teachers, while a low positive correlation between their attitudes towards distance education ($r = .03$). In other words, it can be said that as secondary school mathematics teachers' e-learning readiness increases, their technology acceptance levels and attitudes towards distance education increase.

There is a low positive correlation between secondary school mathematics teachers' technology acceptance level and their attitudes towards distance education ($r = .19$). In other words, it can be said that as secondary school mathematics teachers' technology acceptance levels increase, their attitudes towards distance education increase.

Conclusions and Suggestions

In this study, secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education during the pandemic were examined according to various variables. Furthermore, the correlation between secondary school mathematics teachers' digital literacy self-efficacy, e-

learning readiness, technology acceptance levels, and attitudes towards distance education was examined. As a result of the study, it was concluded that secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, and technology acceptance levels were at a high level and their attitudes towards distance education were moderate. These results are similar to the studies conducted by Dönmez et al. (2022), Gündüzalp (2022), and Ocak et al. (2022) examining the digital literacy levels of teachers in various branches. These results are also similar to the studies conducted by Kabataş (2019), Adıyaman (2020), and Parlak (2021) examining the e-learning readiness of teacher candidates, teachers, and lecturers. These results are also similar to the studies conducted by Binay-Eyuboğlu and Karacaoğlan-Yılmaz (2018), Aktürk and Delen (2020), and Kandemir (2020) examining the technology acceptance levels of teachers at primary, secondary, and high school levels. These results are also similar to the studies conducted by Gündüzalp (2021) and Yassıbaş (2022) investigating teachers' attitudes towards distance education. In studies examining teachers' attitudes towards distance education by Ülkü (2018), Akman (2021), and Timurkan (2021), teachers were observed to have negative attitudes towards distance education. Although the advancement of technology and the use of technology in every field including education show that teachers have adopted technology and have certain qualifications, unpreparedness for distance education during the pandemic, lack of experience, and habits from face-to-face education can be shown as the cause of these results.

In this study, no significant difference was found between secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education during the pandemic and their gender. The results of the studies conducted by Dönmez et al. (2022), Gündüzalp (2022), and Ocak et al. (2022) also show that digital literacy self-efficacy does not differ according to the gender of teachers. Similarly, the results of the study conducted by Adıyaman (2020) show that the e-learning readiness does not differ according to the gender of the teachers. Likewise, the results of the studies conducted by Eyuboğlu (2018) and Binay-Eyuboğlu and Karacaoğlan-Yılmaz (2020) show that the technology acceptance levels do not differ according to the gender of the teachers. Also, the results of the studies conducted by Gündüzalp (2021), Timurkan (2021), and Çelik (2022) show that the attitudes of teachers towards distance education do not differ according to their gender.

In this study, no significant difference was found between secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology

acceptance levels, and attitudes towards distance education during the pandemic and their professional seniority. The results of the studies conducted by Dönmez et al. (2022), Doğan and Birişçi (2022), and Gündüzalp (2022) and Mazlum (2022) indicate that there is no significant difference between digital literacy self-efficacy and professional seniority of teachers. Similarly, the results of the studies conducted by Yurdugül and Demir (2017), Adıyaman (2020), and Parlak (2021) show that the e-learning readiness does not differ according to the professional seniority of the teachers. Likewise, the results of the studies conducted by Eyüboğlu (2018) and Sırakaya (2019) show that the technology acceptance levels do not differ according to the professional seniority of the teachers. Also, the results of the studies conducted by Soydan (2021), Timurkan (2021), and Çelik (2022) show that the attitudes of teachers towards distance education do not differ according to their professional seniority. However, it was detected in the studies that digital literacy self-efficacy, e-learning readiness, technology acceptance level, and attitudes towards distance education of teachers with less professional seniority were high (Ağır et al. 2007; Aktürk & Delen, 2020; Kandemir, 2020; Koca & Tutal, 2021; Yumbul, 2021; Gündüzalp, 2021; Gülay Ogelman et al., 2022; Yurtseven, 2022). When the underlying reasons are considered, it can be concluded that the childhoods of teachers with low seniority are mostly spent with technology, they have received technology education at the university, their excitement about starting a new profession, and their desire to learn.

In this study, no significant difference was found between secondary school mathematics teachers' digital literacy self-efficacy, e-learning readiness, technology acceptance levels, and attitudes towards distance education during the pandemic and their distance education training status. The results of the studies conducted by Korkmaz (2020), Yaman (2020), Buzkurt (2021), and Kara (2021), no significant difference was found between teachers' digital literacy self-efficacy and distance education status. Similarly, the results of the study conducted by Parlak (2021) and Zor (2021) show that the e-learning readiness does not differ according to the distance education status of the teachers. Likewise, the results of the studies conducted by Binay-Eyuboğlu and Karacaoğlan-Yılmaz (2020), and Kandemir (2020) show that the technology acceptance levels do not differ according to the distance education status of the teachers. Also, the results of the studies conducted by Gündüzalp (2021), Timurkan (2021), and Çelik (2022) show that the attitudes of teachers towards distance education do not differentiate according to their status of receiving distance education. However, the results of the studies conducted by Ağır et al. (2007), Deniz (2021),

and Demir (2021) indicate a differentiation in teachers' attitudes towards distance education in favor of those having received distance education.

A positive and high-level correlation was found in the study between the digital literacy self-efficacy and the e-learning readiness of secondary school mathematics teachers. Based on this, it can be said that secondary school mathematics teachers' e-learning readiness increases as their digital literacy self-efficacy increases. Similarly, a moderate positive correlation was determined between the digital literacy self-efficacy and the technology acceptance levels of secondary school mathematics teachers. Based on this, it was concluded that the technology acceptance level of secondary school mathematics teachers increases as their digital literacy self-efficacy increases. A low negative correlation was detected between the digital literacy self-efficacy and the attitudes towards distance education of the secondary school mathematics teachers. A moderate positive correlation was detected between the e-learning readiness and the technology acceptance levels of the secondary school mathematics teachers. This result can be interpreted as the increase of the secondary school mathematics teachers' technology acceptance levels with the increase in their e-learning readiness. A low positive correlation was detected between the e-learning readiness and the attitude towards distance education of the secondary school mathematics teachers. This result may increase to a certain extent in secondary school mathematics teachers' attitudes towards distance education with the increase of their e-learning readiness.

In this study, which was carried out with secondary school mathematics teachers who had both hybrid, distance, and face-to-face teaching experience during the pandemic, teachers' digital literacy levels, e-learning readiness, technology acceptance levels, and attitudes towards distance education were examined according to various variables. As a result of this study, no significant difference was found in terms of teachers' digital literacy levels, e-learning readiness, technology acceptance levels, and attitudes towards distance education according to the variables of gender, seniority, and distance education status. A high level of positive correlation was found between the level of digital literacy and the e-learning readiness, the level of technology acceptance, and the attitude towards distance education, and a moderate positive correlation between the level of digital literacy and the technology acceptance as well as the e-learning readiness and the technology acceptance.

With the onset of the pandemic, there have been some disruptions in e-learning and distance education. The maintenance of education in emergency situations depends entirely

on the performance of teachers and their attitudes towards various variables, self-efficacy levels, and acceptances. In this direction, it is considered important to examine the knowledge, self-efficacy, and skill levels of teachers both in the implementation of up-to-date teaching models that can be used in the integration process of primary learning technologies such as learning blended from innovative approaches and hybrid learning, the integration of technology, and in the healthy execution of distance education applications. In this context, various studies should be carried out to increase the technology acceptance levels, the digital literacy levels, and the e-learning readiness of teachers, and improvements in teachers' attitudes can be achieved by providing professional trainings for distance education. In addition, it is recommended to deepen the study by examining the experiences and opinions of teachers working in disadvantaged schools and having internet problems in terms of the variables examined.

The pandemic in the 21st century has led to problems in the education process having undergone a rapid transformation and the realization of many opportunities such as digital education, hybrid learning, and distance learning. In this context, it is considered important to disseminate digital literacy and teachers with positive affective characteristics about digital technologies, so that the teaching process, which has become inseparable from technology, can create producing and not-consuming brains. Ensuring technology integration for the mathematics course, where abstract concepts are intense, many problems occur even in face-to-face teaching, conceptual understandings emerge, and the ability to ensure effective mathematics teaching in distance education courses are directly related to the knowledge, skills, attitudes, and competences of the teacher. In this direction, in the process of integrating technology into mathematics lessons, evaluations can be made in terms of digital literacy, e-learning readiness, technology acceptance, and attitudes towards distance education, and practices can be carried out.

Compliance with Ethical Standards

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Research involving Human Participants and/or Animals

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Pandemi Sürecinde Ortaokul Matematik Öğretmenlerinin Dijital Okuryazarlık Öz Yeterlikleri, E-öğrenmeye Hazırbulunuşlukları, Teknoloji Kabul Düzeyleri ve Uzaktan Eğitime Yönelik Tutumlarının İncelenmesi

Özet:

Bu araştırmada pandemi sürecinde ortaokul matematik öğretmenlerinin dijital okuryazarlık öz yeterlikleri, e-öğrenmeye hazırbulunuşlukları, teknoloji kabul düzeyleri ve uzaktan eğitime yönelik tutumları incelenmiştir. Araştırmaya Uşak ili ve ilçelerinde görev yapan uygun örnekleme yöntemiyle seçilmiş 108 ortaokul matematik öğretmeni katılmıştır. Veri toplama aracı olarak kişisel bilgi formu, "Dijital Okuryazarlık Öz Yeterliliği Ölçeği", e "E-öğrenmeye Hazırbulunuşluk Ölçeği", "Öğretmenler İçin Teknoloji Kabul Ölçeği" ve "Uzaktan Eğitime Yönelik Tutum Ölçeği" kullanılmıştır. Araştırmada veri analizi için betimsel istatistikler, ilişkisel örneklemler için t testi, tek faktörlü varyans analizi ve çoklu korelasyon analizinden faydalanılmıştır. Araştırmada ortaokul matematik öğretmenlerinin dijital okuryazarlık öz yeterlik düzeylerinin, e-öğrenmeye hazırbulunuşluk düzeylerinin, teknoloji kabul düzeylerinin yüksek düzeyde ve uzaktan eğitime yönelik tutumlarının orta düzeyde olduğu sonucuna ulaşılmıştır. Ortaokul matematik öğretmenlerinin dijital okuryazarlık öz yeterlikleri ile e-öğrenmeye hazırbulunuşlukları arasında pozitif yönde ve yüksek düzeyde, teknoloji kabul düzeyleri arasında pozitif yönde orta düzeyde, uzaktan eğitime yönelik tutumları arasında ise negatif yönde düşük ilişki olduğu tespit edilmiştir. Ayrıca e-öğrenmeye hazırbulunuşlukları ile teknoloji kabulleri arasında pozitif yönde orta düzeyde ilişki varken uzaktan eğitime yönelik tutumları arasında ise pozitif yönde düşük düzeyde ilişki olduğu belirlenmiştir.

Anahtar kelimeler: Pandemi, Uzaktan Eğitim ve Matematik Öğretmeni

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Research Article

Examination of Primary and Secondary School Mathematics Textbooks in Terms of Root Values

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Abstract – This study was conducted to examine mathematics textbooks in terms of the root values in the curriculum. For this purpose, 8 mathematics textbooks taught in primary and secondary schools in the 2022-2023 academic year were examined regarding root values. Document analysis method, one of the qualitative research methods, was used in the study. The identified textbooks were subjected to first-read by the researchers, and the expressions thought to contain value statements were identified. The study observed that the number of root values in elementary school mathematics textbooks decreased as the grade level increased. In primary school textbooks, the value of responsibility is the most common, and the value of honesty is the least common. In middle school mathematics textbooks, root values decrease as the grade level increases (except sixth grade). While responsibility and benevolence are the most common values in middle school textbooks, respect is the least common. According to these results, it is recommended that primary and secondary school mathematics textbooks should include a greater number and variety of value statements and that textbooks should be prepared with an equal distribution of these values according to grade levels and values.

Keywords: Mathematics textbook, primary school, secondary school, root values.

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Introduction

Since man is a social being, he maintains his ties with his culture and other societies in the world through rules and cultural elements to create harmony between many equations in his life and ensure his continuity. One of these elements is values (Ergül, 2019). Value is defined in the dictionary as “an abstract measure used to determine the importance of

something, the value of something; magnificence, might, worth" (Turkish Language Association [TLA], 2023). Cevizci (2006) explained value as a basis of belief and facts that are important for making sense of life and shaping daily life. On the other hand, Bacanlı and Dombay (2012) stated that value could be accepted as a belief belonging to our internal structure that serves as a source of behaviours and helps to judge them. "Values are meaningful concepts that try to teach individuals, who are the building blocks of society, what is important and what kind of behaviour should be preferred in which situations" (Topal, 2019: 248). Individuals living in a society form their value judgments by adopting the values accepted in the society. These value judgments formed by individuals lead to the emergence of society's values (Gerekten, 2018). Values and society are intertwined phenomena that cannot be separated like flesh and nail.

People try to distinguish right from wrong based on traditions, custom, and social rules; within this framework, they form a measure of moral rules. This measure encompasses a set of beliefs that can also be called values or educational values. The fact that individuals evaluate the events they encounter throughout their lives and the people and phenomena around them within the framework of this conviction constitute a principle of behaviour. This principle is the general name of the order approved by the society and covers a nation's material and spiritual elements. These phenomena, which may vary from society to society, may become an acquisition over time. Permanentisation of values is possible with adult and peer support based on social learning. The first step in becoming an individual who can think healthy and has a conscious thinking ability is through a qualified values education (Ay & Topçuğlu Ünal, 2020).

Since individuals are a part of the society they live in, they interact with the society. The individual is a being that influences and is influenced by the society in which he/she lives. Transferring society's values and common behaviour patterns to the individual and internalizing them enables the individual to adapt to society and see himself/herself as a part of society. Values have existed since the past, and adding new ones to the values from the past provides a bridge between the past and the future. The strength and continuity of a society are directly related to this bridge. It is not possible to talk about the future of a society that has broken away from its past and destroyed the bridge between it and its past. For this reason, values teaching should not be left to chance. The most potential institutions that can do this work systematically and carefully are our schools (Erdal, 2019). While values can be acquired through language, systematic teaching is needed for these values to become permanent and

sustainable. It would be useful to utilize schools for this need. “Being a good and virtuous person and raising individuals with strong character is one of the most important goals of school and society. Realizing this goal depends on transferring social and cultural values to future generations” (Karatay, 2011: 1441).

The future of a society is only possible if the future generations of that society protect their values. Based on this, especially formal education schools should endeavour to provide students with society's values and make it an important goal to give the students values (Sallabaş & Dağ, 2020). Especially during the compulsory education process, our values should be given to students both implicitly and directly, and it should be ensured that our values are passed on to future generations. Here, every element of education, such as parents, students, teachers, and administrators, must do their part, otherwise, teaching these values will become more difficult day by day, and one day they will disappear.

The acceleration of technological developments in the developing and changing world has facilitated the communication of societies with each other and the transfer of their cultures to each other. Since values may vary according to society, a value considered important in one society may not be welcomed in another society (Yaman, 2016). The easy transfer of values from society to society sometimes leads to changes in our society. It may cause our future generations to grow up without learning our own values or to grow up with values that do not coincide with our society. For this reason, it is important to provide values education to our students in education. Values education aims to raise individuals in line with common and acceptable behaviours in society. Values education aims to reduce societal conflicts and problems, ensure society's continuity, and provide a regular and systematic future for future generations (Ay & Topçuğlu Ünal, 2020). Values education aims to raise good individuals who are moral, have a well-established personality, are self-confident, and aim to benefit both their society and the world. Another issue to be considered in values education is that people transform the information they learn into behaviour in their lives. The main goal of values education should be to recognize and understand oneself and maximize these abilities while going through these processes. In values education, the importance of basic values in people's relations with others should also be emphasized (Çağlayan, 2006). An individual who has received values education well and internalized these values will struggle not only for his/her happiness but also for the happiness of society by adopting individual values such as respect, love, and freedom to live and social values such as love for humanity, love for homeland and nation (Salar, 2011).

Researchers state that values education has become a need rather than being important (Yaman, 2016). The acquisition of basic values by students is of critical importance both in social life and in the student's life success. Based on this importance, activities within the scope of values education are included in schools (Ginesar & Katılmış, 2021). The Ministry of National Education (MoNE) has been including values education in education curriculum since 2005. In 2010, studies on values education gained momentum and values education became one of the important components of the 2018 curriculum that is still in use today (Gerekten, 2018). In the 2018 curriculum, MoNE stated that it does not see values as a separate program or learning area, subject, or unit. On the contrary, values are the main purpose and spirit of the education process. Based on this, values are included in the education programs of all courses regardless of branch. These root values are 10 and are listed as follows: justice, friendship, honesty, self-control, patience, respect, love, responsibility, patriotism, and helpfulness.

It is undeniable that mathematics is the most important course for most students throughout their education, due to society's difficulties and pressure. For this reason, giving the right place to values education in the mathematics course, perhaps the most important course for students, will enable them to understand the importance of values education. Values education can be included in many stages of mathematics teaching. While motivating the students to the lesson, while explaining the subject, while doing activities with the students, and/or in the measurement and evaluation part of the lesson, these root values in our education and training program can be included. One of the important parts of education is course materials. Among these course materials, textbooks are the ones that all students have. Textbooks are the most basic educational tool used in schools to achieve the goals and objectives in the curriculum and to transfer the learning outcomes, concepts, values, and skills to students (Hussain, 2012). Textbooks, the main source of information for teachers and students, are the most widely used course materials in our country, as in many countries (Kılıç & Seven, 2007). Although visual, auditory, and printed technological teaching tools have started to be used in schools with the development of technology, most teachers still rely on textbooks for their daily lesson plans or activities (Elliott, 1992; Gibson, 2012; Woodward, 1993). While textbooks guide teachers on what to teach, they also help students gain certain skills, such as following the learning outcomes, practicing exercises, and self-evaluation (Brousseau, 1986; Demirkaya, 2013; Johansson; 2003; Kayabaşı, 2003; Semerci, 2004). Şen (2008) stated that textbooks provide students' language and cognitive development and also

have an important role in the formation of students' personalities. It is thought that books prepared for children have important effects on their character development and that individuals should be fed with books suitable for their character traits from the beginning of primary school to the end of secondary school (Sever, 2008). Therefore, the content in the textbooks must be rich, contain examples from daily life, visual expressions must be frequently used, the language must be understandable, and it must effectively convey the values specified in the curriculum (Güven, 2010; Korkmaz et al., 2020). It is essential that textbooks, frequently used in applied courses such as mathematics, are well-prepared and provide students with quality content. Because all knowledge students acquire through textbooks is considered an essential gain for society (Dane et al., 2004). Therefore, it is important to investigate to what extent and how values education is included in primary and secondary school mathematics textbooks.

In the literature review, there are studies in which Turkish (Durhat & Ökten, 2020; Eken & Öksüz, 2019; Şen, 2008) Science (Yılmaz & Kıran, 2023) and Social Studies textbooks (Kuş et al., 2013) were examined in the context of values education. When the studies examining mathematics textbooks are concerned, it is seen that these studies were reviewed in terms of features such as technological suitability (Sevimli & Kul, 2015), abstraction skills (Kılıçoğlu, 2020), mathematical proof (Zeybek et al., 2018), history of mathematics (Mersin & Durmuş, 2018). In addition, Korkmaz et al. (2020) examined mathematics textbooks according to their suitability for the High School Entrance Examination (LGS), active use in the teaching process, and suitability for the curriculum applied in schools. There have also been studies examining fifth grade mathematics textbooks in Turkey and Singapore in terms of solved examples and questions and according to PISA basic mathematics skill levels (Şirin & Yıldız, 2020; Toprak & Özmantar, 2019). When the studies examining mathematics textbooks in terms of values education are concerned, although there are studies examining primary school third and fourth grade books (Uzunkol & Karaca, 2019), secondary school mathematics textbooks (Horzum & Yıldız, 2023; Özenç, 2019; Sayın et al., 2019; Şahin & Başgül, 2018) and secondary mathematics textbooks (Teker & Ellez, 2022) in terms of values education, there is no research examining all mathematics textbooks at primary and secondary school level. In this context, this study aims to examine the root values in mathematics textbooks of primary (first, second, third and fourth grades) and secondary schools (fifth, sixth, seventh and eighth grades). In line with this purpose, answers to the following problems were sought.

1. How is the distribution of root values in primary school mathematics textbooks?
2. How does root values distribution in primary school mathematics textbooks according to learning areas?
3. How is the distribution of root values in secondary school mathematics textbooks?
4. How does root values distribution in secondary school mathematics textbooks according to learning areas?

Method

Study Model

Document analysis is a qualitative research method preferred for systematically analysing written, visual and auditory documents to make sense of the data obtained or to understand the subject (Corbin & Strauss, 2008; Wach & Ward, 2013). This study preferred this method because primary and secondary school mathematics textbooks, which are written documents, were analysed in terms of the root values they contain.

Study Document

In the study, 8 textbooks, one at each grade level, were selected from the textbooks of private publishers determined by the Ministry of National Education to be taught in primary and secondary schools in the 2022-2023 academic year. These textbooks were selected because they were being taught in the city where the first author worked at the time of the study. Detailed information about the analysed textbooks is presented in Table 1.

Table 1 Information on primary and secondary school mathematics textbooks examined within the scope of the study

Class	Book Name	Publisher	Authors	Number of Pages
First Grade	Primary School Mathematics Textbook First Grade	Açılım Education and Training	Nuri Cantürk	208
Second Grade	Primary School Mathematics Second Grade Textbook	Pasifik Publishing	Ayşegül Arzu Bayram	240
Third Grade	Primary School Mathematics 3 Textbook	Tuna Printing	Orhan Bilen	272
Fourth Grade	Primary School Mathematics 4 Textbook	Sevgi Publishing	Ekrem Aydin, Mehmet Ali Erenkuş	248

Fifth Grade	Secondary and Imam Hatip Secondary School Mathematics Textbook Fifth Grade	Özgün Printing	Gülçin Göksülük	264
Sixth Grade	Secondary and Imam Hatip Secondary School Mathematics Textbook Sixth Grade	Koza Publishing	Ekrem Aydın, Mehmet Ali Erenkuş	246
Seventh Grade	Middle School and Imam Hatip Secondary School Mathematics Textbook Seventh Grade	Berkay Publishing	Bülent Akbulut	256
Eighth Grade	Secondary School and Imam Hatip Secondary School Mathematics 8 Textbook	Koza Publishing	Mehmet Ali Erenkuş, Didem Eren Savaşkan	276

Data Collection

In this study, mathematics textbooks were analysed in terms of root values, firstly, the textbooks to be included in the study were determined. The determined books consist of 8 sets of textbooks belonging to private publishing houses that are approved to be taught by the Ministry of National Education in the 2022-2023 academic year and are currently used as textbooks. After the textbooks were obtained in both physical and digital media, they were read twice by the researchers at different times for the purpose of the study and associated with the value statements. The root values used in associating value statements with root values and the information about the attitudes and behaviours associated with these values are given in Table 2 (Presidency of the Board of Education [PoBE], 2017: 22). Afterwards, the researchers came together at certain times. They discussed the values determined by both researchers and the statements corresponding to these values, and it was decided to gather the statements under appropriate value headings.

Table 2 Root values in the curriculum and attitudes and behaviours related to values

Root Values	Attitudes and Behaviours Related to Root Values
Responsibility	Being responsible to oneself, one's environment, family, and homeland; keeping one's word, being consistent and reliable; taking the consequences of one's actions...
Affection	Expressing love appropriately, making sacrifices, being trusting, compassionate, caring about family unity, being altruistic, being loyal...
Friendship	Altruism, trust, understanding, solidarity, loyalty, faithfulness, charity...
Benevolence	Being generous, cooperating, compassionate, hospitable, sharing, solidarity, offering support...
Justice	Fairness, equal treatment, sharing...
Patience	Being determined, enduring, knowing how to wait, being resilient and durable, persevering...
Honesty	To be clear and understandable, to be truthful, to be decent and stable, to be reliable, to keep promises...

Self-audit	Controlling behaviours, taking responsibility for their behaviour, having self-confidence, apologizing when necessary...
Respect	Humility, treating others how one would like to be treated, valuing other people's personalities, considering the interlocutor's position, characteristics, and situation...
Patriotism	Being hardworking and productive, solidarity, obeying rules and laws, being loyal, being sensitive to historical and natural heritage, caring about society, being participatory...

Analysis of Data

Primary and secondary school mathematics textbooks were first-read by the researchers, and the expressions in the textbooks that were thought to contain the concept of value were determined. The identified statements were independently associated with root values by both researchers. Then, the researchers came together and checked each value-containing statement one by one from the textbooks. The values on which consensus was reached were taken as they were. The value statements that could not be agreed upon or that one researcher identified as a value statement, but the other researcher did not, were examined together. As a result of the examination, the statements containing undecided values were also associated with a value resulting from a joint decision. In this way, the inter-coder agreement rate was calculated based on the expressions containing values for which consensus was reached or for which consensus could not be reached. As a result, the inter-coder agreement was calculated as 0.89 $(Consensus/Consensus+Disagreement)\times 100$ (Miles & Huberman, 1994).

Validity and Reliability

The validity and reliability provided by numerical indicators in quantitative research are done differently in qualitative research. In qualitative research, it is necessary to ensure credibility for internal validity, transferability for external validity, consistency for internal reliability, and confirmability for external reliability (Yıldırım & Şimşek, 2006). In this context, the measures taken to ensure validity and reliability in the research are as follows.

- The research process was planned and explained in detail by the researchers.
- Both researchers had long-term interactions with the textbooks.
- To ensure the consistency of the data sets created by the researchers, the researchers examined the textbooks more than once at different times, and the results were checked together.
- The researchers keep the textbooks and the raw data sets created digitally.

- The findings obtained after data analysis were supported with numerical data (percentage, frequency).
- Examples of the findings obtained from the textbooks are shown.
- The agreement rate between the researchers for the obtained data was calculated.

Findings

Findings related to the first sub-problem of the study

In the first sub-problem of the research, the findings obtained from the examination of primary school mathematics textbooks in terms of root values are given in Table 3.

Table 3 Root values in elementary school mathematics textbooks and their frequency of inclusion

Value	First Grade	Second Grade	Third Grade	Fourth Grade	f (%)
Responsibility	19	7	20	12	58 (23%)
Affection	1	11	4	7	23 (9.13%)
Friendship	4	5	10	1	20 (7.94%)
Benevolence	13	7	5	7	32 (12.7%)
Justice	2	4	8	1	15 (5.95%)
Patience	7	8	8	8	31 (12.3%)
Honesty	-	1	1	2	4 (1.59%)
Self-audit	3	11	5	2	21 (8.33%)
Respect	17	8	1	7	33 (13.1%)
Patriotism	4	5	4	2	15 (5.96%)
Total	70	67	66	49	252

When Table 3 is examined, 252 expressions containing value were identified in primary school mathematics textbooks. The textbook with the highest number of these value statements was the first grade textbook with 70 value statements. The first grade textbook is followed by the second grade textbook with 67 value statements and the third grade textbook with 66 value statements. The textbook with the least number of value statements is the fourth grade textbook with 49 value statements.

Responsibility is the most common value in primary school mathematics textbooks, with 58 (23%). This value is followed by respect with 33 (13.1%), benevolence with 32 (12.7%), patience with 31 (12.3%), love with 23 (9.13%), self-control with 21 (7.94%), friendship with 20 (7.94%), justice and patriotism with 15 (5.96%) each. The least common value is honesty, with 4 (1.59%). The results and examples of analysis for each value in the textbooks according to grade levels are given below.

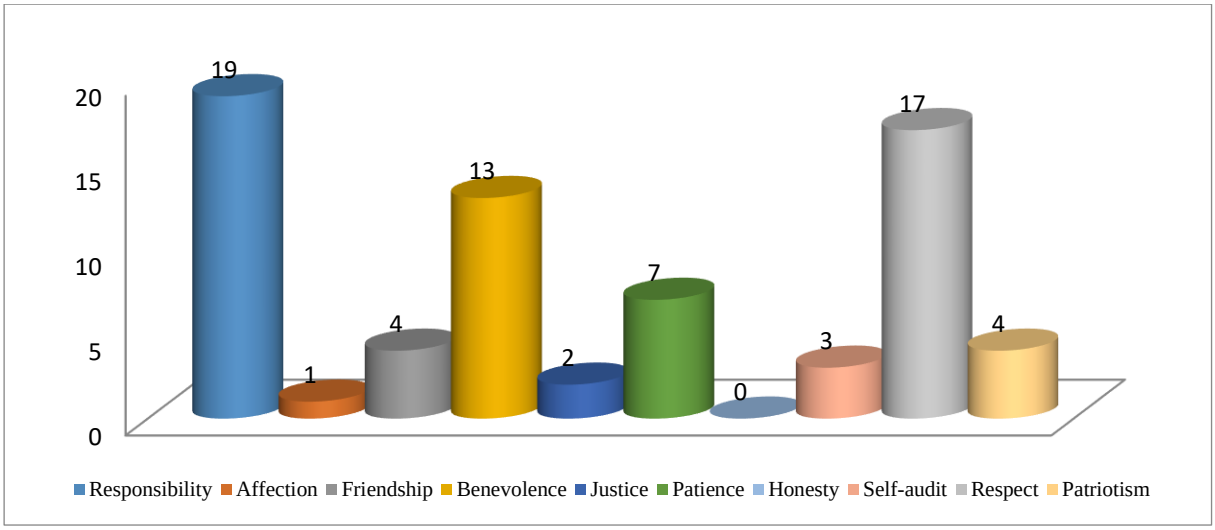


Figure 1 Values in the first grade mathematics textbook

According to the frequency graphic of the values in the first grade mathematics textbook, the most common value was responsibility, with 19 (27.1%). Responsibility is followed by respect with 17 (24.3%), benevolence with 13 (18.6%), patience with 7 (10%), friendship and patriotism with 4 (5.7%) each, self-control with 3 (4.3%) and justice with 2 (2.9%). The least common value was love, with 1 (1.4%). The expression, including the value of honesty, was not found in the textbook. An example of the value of respect in the first grade mathematics textbook is presented below.

Turkish	English
 Annesi, Alíye buzdolabında kaç tane yumurta olduğunu soruyor. Ali, buzdolabındaki yumurtaların sayısını nasıl bulabilir? Tartışınız. Söylenilen fikirlere katılmasanız da saygı gösteriniz.	His mother asks Ali how many eggs there in the fridge are. How can Ali find the number of eggs in the refrigerator? Make a discussion. Show respect even if you disagree with the ideas expressed.

Figure 2 The value of respect in the first grade mathematics textbook

In preparation for the topic in Unit 2 (p. 36) of the first grade mathematics textbook, it is explained that even if one disagrees with the ideas expressed during the discussion, one should value and respect the personalities of those people.

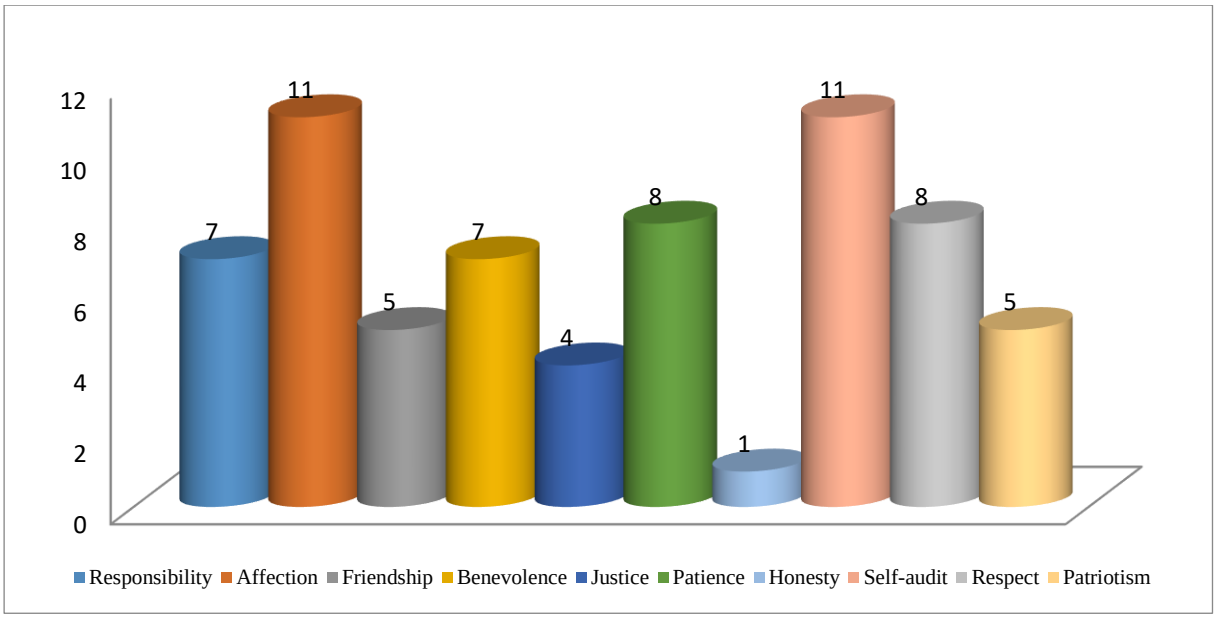
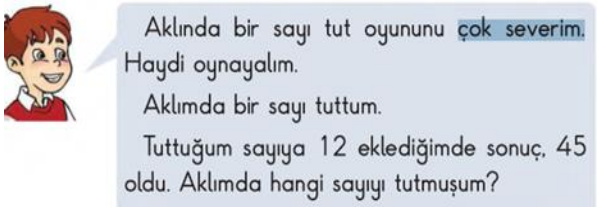


Figure 3 Values in the second grade mathematics textbook

According to the frequency graphic of the values in the second grade mathematics textbook, the most common values were love and self-control, with 11 (16.4%) each. This is followed by the values of patience and self-control with 8 (11.9%) each, responsibility and benevolence with 7 (10.5%) each; friendship and patriotism with 5 (7.5%) each; and justice with 4 (6%). The least common value was honesty, with 1 (1.5%). An example of the value of love in the second grade mathematics textbook is presented below.



I like to play to keep a number in mind. Let's play.
I have a number in my mind.
When I added 12 to the number I kept, I got the result as 45. Which number did I hold in my mind?

Turkish English

Figure 4 The value of love in the second grade mathematics textbook

In Unit 2 (p. 68) of the second grade mathematics textbook, in the section where short information and explanations on the subject are given with various questions, the student who made a speech expressed his love appropriately by saying that he loved the number-keeping game very much. This expression emphasizes the value of love.

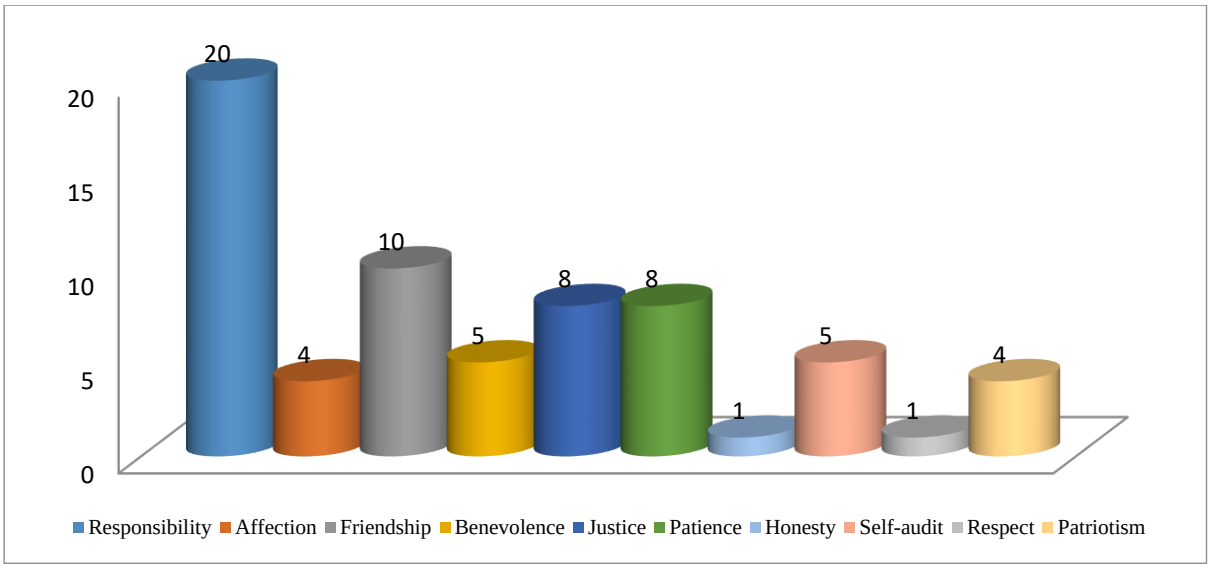


Figure 5 Values in the third grade mathematics textbook

According to the frequency graphic of the values in the third grade mathematics textbook, the most common value was responsibility, with 20 values (30.3%). The values of friendship with 10 (15.2%), justice and patience with 8 (12.1%), benevolence and self-control with 5 (7.6%), and love and patriotism with 4 (6%) each. The least common values were honesty and respect, with 1 (1.5%) each. An example of the value of justice in the third grade mathematics textbook is presented below.

Selim ile Seda'nın annesi yaptığı kurabiyelerden her tabağa dörder tane koyarak Selim ile Seda'ya verdi. Selim ile Seda kurabiyeleri çok beğenince Selim'e 2, Seda'ya ise 3 kurabiye daha verdi. Hangisine tek sayıda, hangisine çift sayıda kurabiye verdi?

Turkish

Seda's mother put four cookies on each plate and gave Selim and Seda. When Selim and Seda liked the cookies very much, she gave 2 more cookies to Selim and 3 more cookies to Seda. Which of them received an odd number of cookies, and which received an even number?

English

Figure 6 The value of justice in the third grade mathematics textbook

In Unit 1 of the third grade mathematics textbook (p. 37), in the section with questions measuring readiness for the subject, the mother's placing four cookies on each plate is an example of equal sharing and can be shown as an example of the value of justice.

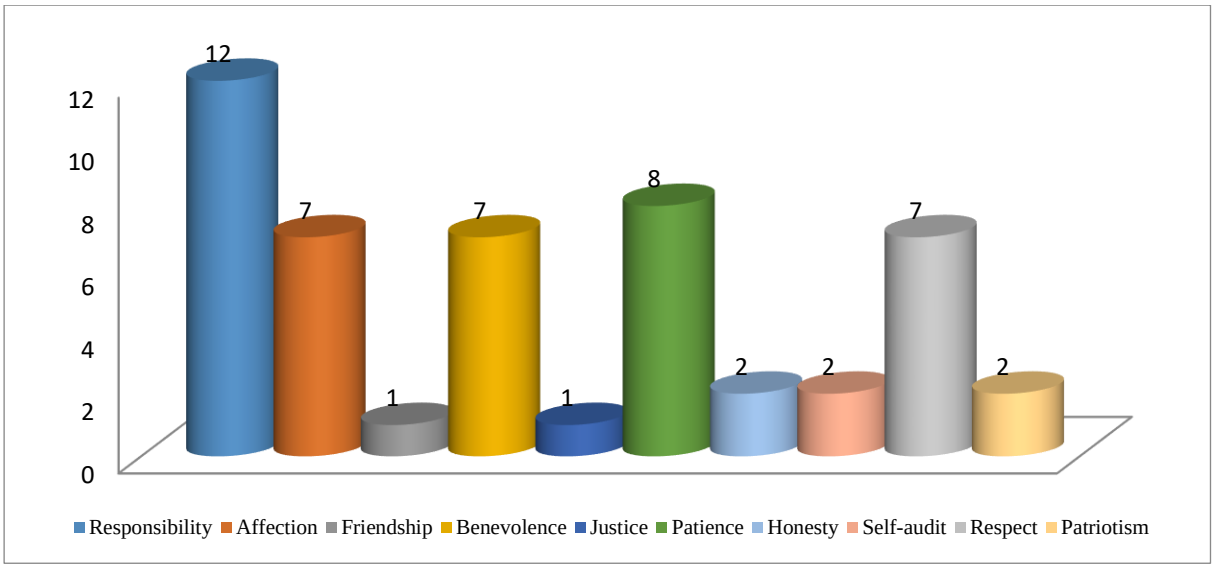


Figure 7 Values in the fourth grade mathematics textbook

According to the frequency graphic of the values in the fourth grade mathematics textbook, the most common value in the textbook was responsibility, with 12 (24.5%). Responsibility is followed by patience with 8 (16.3%); love, helpfulness, and respect with 7 (14.3%) each; and honesty, self-control, and patriotism with 2 (4.1%) each. The least common values were friendship and justice, with 1 (2%) each. An example of the value of patience in the fourth grade mathematics textbook is presented below.

Ahmet ile arkadaşları, bir filmi izlemek için bilet kuyruğunda sabırla bekleyip biletlerini aldılar. Film izlenirken sinema salonundaki 324 koltuktan 86 tanesi boş kaldı. Filmi izleyenlerin kaç kişi olduğunu tahmin edelim. 324 ve 86'yı en yakın onluğa yuvarlayarak çıkarma işlemini yapalım. 324 → 320 86 → − 90 230 kişi filmi izlemiştir. 	Ahmet and his friends waited patiently in line for tickets to see a movie and bought their tickets. While watching the movie, 86 of the 324 seats remained empty. Let's estimate how many people watched the movie. Let's subtract 324 and 86 by rounding to the nearest decimal.
Turkish	English

Figure 8 The value of patience in the fourth grade mathematics textbook

In Unit 3 of the fourth grade mathematics textbook (p. 58), in the section where an example of the subject is shown, children waiting in line to watch a movie exemplify the value of patience.

Findings related to the second sub-problem of the study

In the second sub-problem of the study, the findings regarding the distribution of root values in primary school mathematics textbooks according to learning areas are given in Table 4.

Table 4 Distribution of values in primary school mathematics textbooks according to learning areas

First Grade		Second Grade		Third Grade		Fourth Grade	
Learning Area	f (%)	Learning Area	f (%)	Learning Area	f (%)	Learning Area	f (%)
Numbers and Operations	41 (53.2)	Numbers and Operations	43 (64.1)	Numbers and Operations	36 (54.6)	Numbers and Operations	26 (53.1)
Geometry	13 (16.9)	Geometry	5 (7.5)	Geometry	1 (1.5)	Geometry	6 (12.2)
Measurement	20 (26)	Measurement	14 (20.9)	Measurement	28 (42.4)	Measurement	11 (22.5)
Data Processing	3 (3.9)	Data Processing	5 (7.5)	Data Processing	1 (1.5)	Data Processing	6 (12.2)
Total	77	Total	67	Total	66	Total	49

When Table 4 is examined, there are 77 values in the learning areas of the first grade mathematics textbook. Since 5 of these values were included as explanations in the unit evaluation section, they were included in more than one learning area. Therefore, the 70 values identified in the first grade mathematics textbook are seen as 77 in the table of learning areas. For example, the value of patience in the statement “Answer the following questions patiently after reading and understanding them to the end.” on page 172 is included as an explanation in the “Let's Evaluate the Unit” section of Unit 5. Since this unit covers numbers and operations, measurement, and geometry, this value expression is shown in all three learning areas. This is not the case in other classes.

According to these explanations, the first grade mathematics textbook values are mostly included in the learning area of numbers and operations, with 41 values (53.2%). The learning area of numbers and operations is followed by measurement and geometry, with 20 (26%) and 13 (16.9%) values, respectively. In contrast, data processing is the learning area with the least number of values, with 3 values (3.9%). The values in the second grade mathematics textbook are mostly found in the learning area of numbers and operations, with 43 values (64.1%). The numbers and operations learning area is followed by measurement with 14 values (20.9%), geometry and data processing learning area s with 5 values (7.5%) each. The values in the third grade mathematics textbook are mostly found in the learning area of numbers and operations, with 36 values (54.6%). The numbers and operations learning area is followed by

the measurement learning area with 28 values (42.4%), while geometry and data processing learning areas have 1 value each (1.5%). The values in the fourth grade mathematics textbook are mostly found in the numbers and operations learning area, with 26 values (53.1%). The numbers and operations learning area is followed by the measurement learning area with 11 values (22.5%), while geometry and data processing learning area s have 6 values (12.2%) each.

Findings related to the third sub-problem of the study

In the third sub-problem of the research, the findings obtained from examining secondary school mathematics textbooks in terms of root values are given in Table 5.

Table 5 Root values in middle school mathematics textbooks and their frequency of inclusion

Value	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade	f (%)
Responsibility	6	4	10	3	23 (16.6%)
Affection	10	6	4	8	28 (20.1%)
Friendship	4	8	3	2	17 (12.2%)
Benevolence	7	5	5	6	23 (16.6%)
Justice	7	3	-	1	11 (7.9%)
Patience	7	-	4	-	11 (7.9%)
Honesty	3	1	1	1	6 (4.3%)
Self-audit	2	2	3	2	9 (6.4%)
Respect	1	1	-	1	3 (2.2%)
Patriotism	5	1	2	-	8 (5.8%)
Total	52	31	32	24	139

When Table 5 is examined, 139 expressions containing value were identified in middle school mathematics textbooks. The textbook with the highest number of these value statements was the fifth grade textbook with 52 value statements. The fifth grade textbook is followed by the seventh grade textbook with 32 value statements and the sixth grade textbook with 31 value statements. The textbook with the least number of value statements is the eighth grade textbook with 24 value statements.

The most common value in middle school mathematics textbooks is the value of love, with 28 (20.1%). This value is followed by responsibility and benevolence with 23 (16.6%) each, friendship with 17 (12.2%), justice and patience with 11 (7.9%) each, self-control with 9 (6.4%), patriotism with 8 (5.8%) and honesty with 6 (4.3%). The least common value is respect, with 3 (2.2%). The results and examples of analysis for each value in the textbooks according to grade levels are given below.

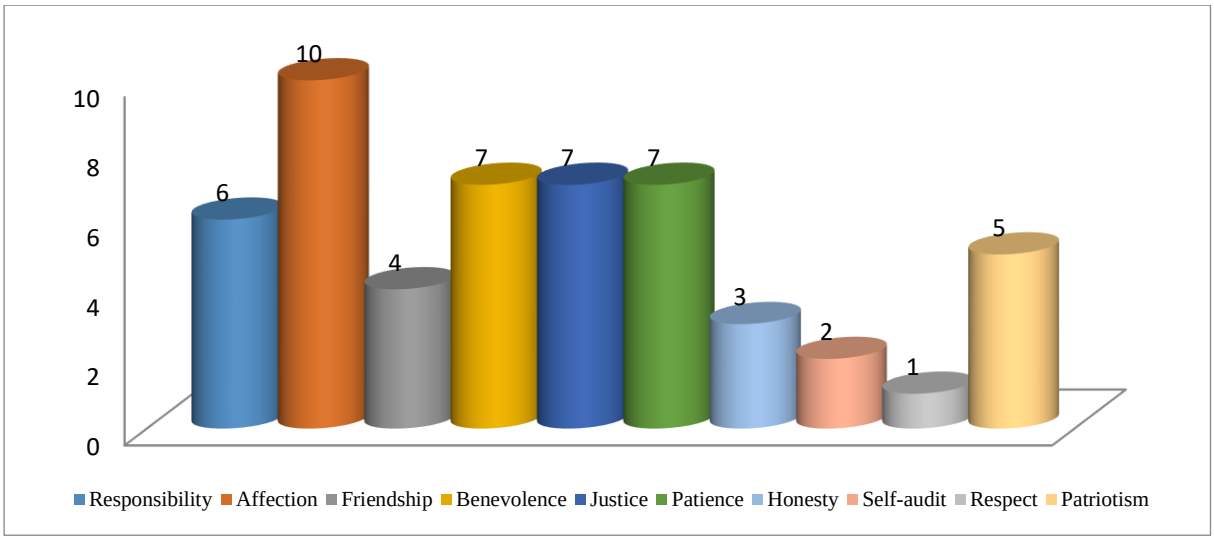


Figure 9 Values in the fifth grade mathematics textbook

According to the frequency graphic of the values in the fifth grade mathematics textbook, the most common value was the value of love with 10 (19.2%). The values of benevolence, justice, and patience follow the value of love with 7 values (13.5%) each; responsibility with 6 values (11.5%), patriotism with 5 values (9.6%), friendship with 4 values (7.7%), honesty with 3 values (5.8%) and self-control with 2 values (3.8%). The least common value was respect with 1 (1.9%). An example of the value of friendship in the fifth grade mathematics textbook is presented below.

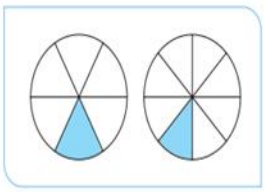
Turkish	English
1. İki arkadaş pastaneye gittiler. Sezgin, 8 eş parçaya bölünmüş pastadan bir dilim yedi. Buse ise aynı büyüklükte ve 6 eş parçaya bölünmüş pastadan bir dilim yedi. İki arkadaştan hangisinin daha çok pasta yediğini bulalım:  Sezgin'in yediği pasta miktarı $\frac{1}{8}$, Buse'nin yediği pasta miktarı $\frac{1}{6}$ kesri ile gösterilir. Modellerdeki parçaların büyüklüklerinden anlaşılacağı gibi Buse, Sezgin'den daha çok pasta yemiştir. Öyleyse $\frac{1}{6} > \frac{1}{8}$'dir.	The two friends went to the bakery. Sezgin ate a slice of the cake cut into 8 equal pieces. Buse ate a slice of the same-sized cake cut into 6 equal pieces. Let's find out which of the two friends ate more cake: Sezgin ate 1/8 of the cake, and Buse ate 1/6 of the cake. As can be seen from the size of the pieces in the models, Buse ate more cake than Sezgin. Therefore 1/6 > 1/8.

Figure 10 Friendship value in the fifth grade mathematics textbook

In Unit 2 of the fifth grade mathematics textbook (p. 74), in the section where sample solutions related to the subjects are explained, two friends going to a bakery exemplify friendship's value.

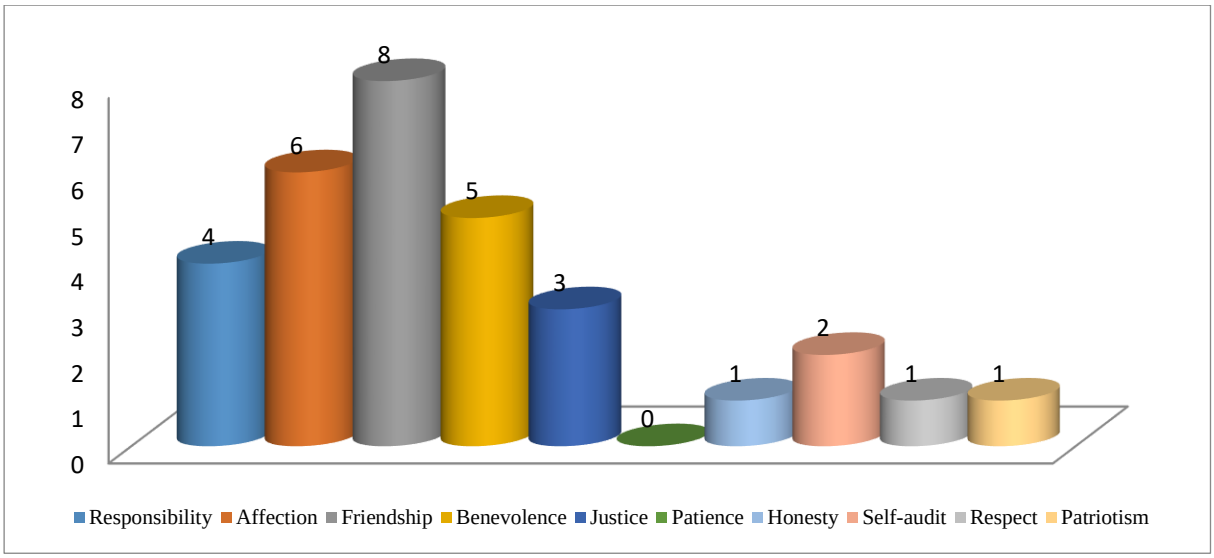


Figure 11 Values in the sixth grade mathematics textbook

According to the frequency graphic of the values in the sixth grade mathematics textbook, the most common value in the textbook was friendship, with 8 (25.8%). Friendship value is followed by love value with 6 (19.4%), benevolence value with 5 (16.1%), responsibility value with 4 (12.9%), justice value with 3 (9.7%) and self-control value with 2 (6.5%). The least common values were honesty, respect, and patriotism, with 1 (3.2%) each. No expression containing the value of patience was found in the textbook. An example of the patriotism value in the sixth grade mathematics textbook is presented below.


Keban Barajı elektrik üretmek ve etrafındaki tarım arazilerini sulamak amacıyla Fırat Nehri üzerine yapılmıştır.

Keban Barajı'nın oluşturduğu göldeki suyun hacmi 31 000 000 000 m^3'tür (otuz bir milyar metreküp).

Keban Barajı'nın oluşturduğu göldeki suyun hacmini ifade eden ölçme birimi hakkındaki düşüncenizi açıklayınız.

Keban Dam was built on the Euphrates River to generate electricity and irrigate the surrounding agricultural lands.

The lake's water volume formed by the Keban Dam is 31,000,000,000 m^3 (thirty-one billion cubic meters).

Explain your opinion about the unit of measurement expressing the volume of water in the lake formed by the Keban Dam.

Turkish English

Figure 12 Patriotism value in the sixth grade mathematics textbook

In Unit 6 (p. 215) of the sixth grade mathematics textbook, in the section with questions associated with photographs to prepare for the subject to be covered, the Keban Dam, which is built to irrigate our country's lands, was constructed to benefit society. The work done to care for society can be an example of patriotism's value.

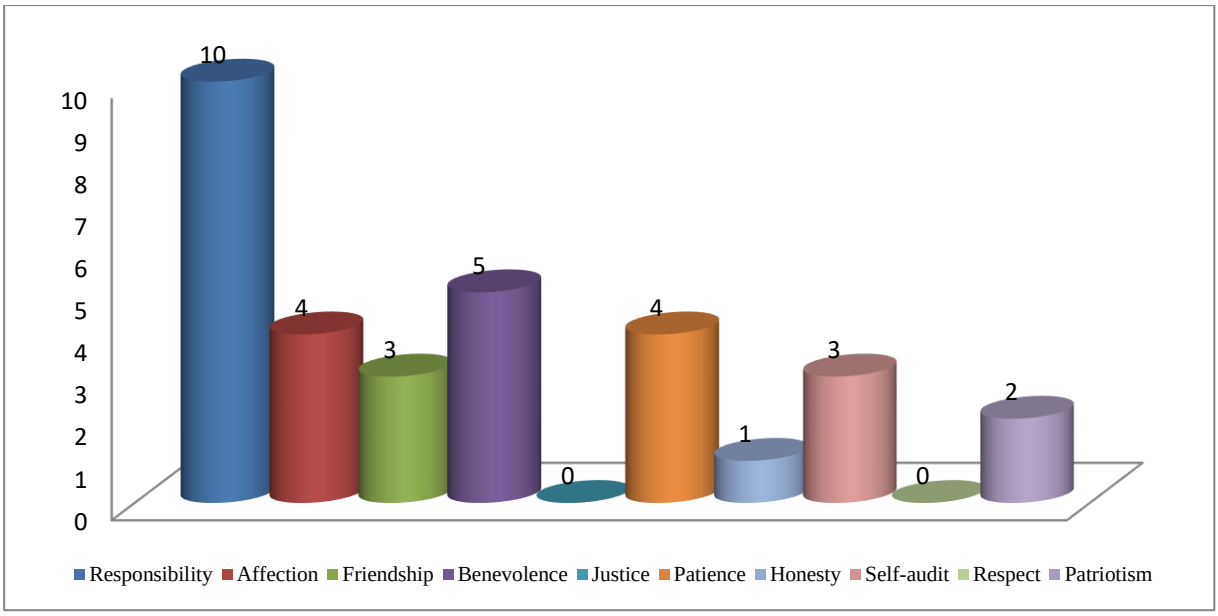


Figure 13 Values in the seventh grade mathematics textbook

According to the frequency graphic of the values in the seventh grade mathematics textbook, the most common value was responsibility, with 10 values (31.2%). Responsibility is followed by helpfulness with 5 (15.6%), love and patience with 4 (12.5%), friendship and self-control with 3 (9.4%), patriotism with 2 (6.3%) and honesty with 1 (3.1%). There are no expressions in the textbook that include the values of justice and respect. An example of the value of honesty in the seventh grade mathematics textbook is presented below.

Bir hayvanat bahçesindeki hayvanların %15'i önceden söz verildiği için başka bir ülkeye gönderilmiştir. Hayvanat bahçesinde 170 hayvan kaldığına göre başka ülkeye gönderilmeden önce kaç hayvan vardı?	15% of the animals in a zoo have been sent to another country because they were promised in advance. Since 170 animals remain in the zoo, how many were there before being sent to another country?
Turkish	English

Figure 14 Honesty value in the seventh grade mathematics textbook

In Unit 4 (p. 135) of the seventh grade mathematics textbook, the zoo authorities' standing behind their promises in the section with practice questions can be given as an example of the value of honesty.

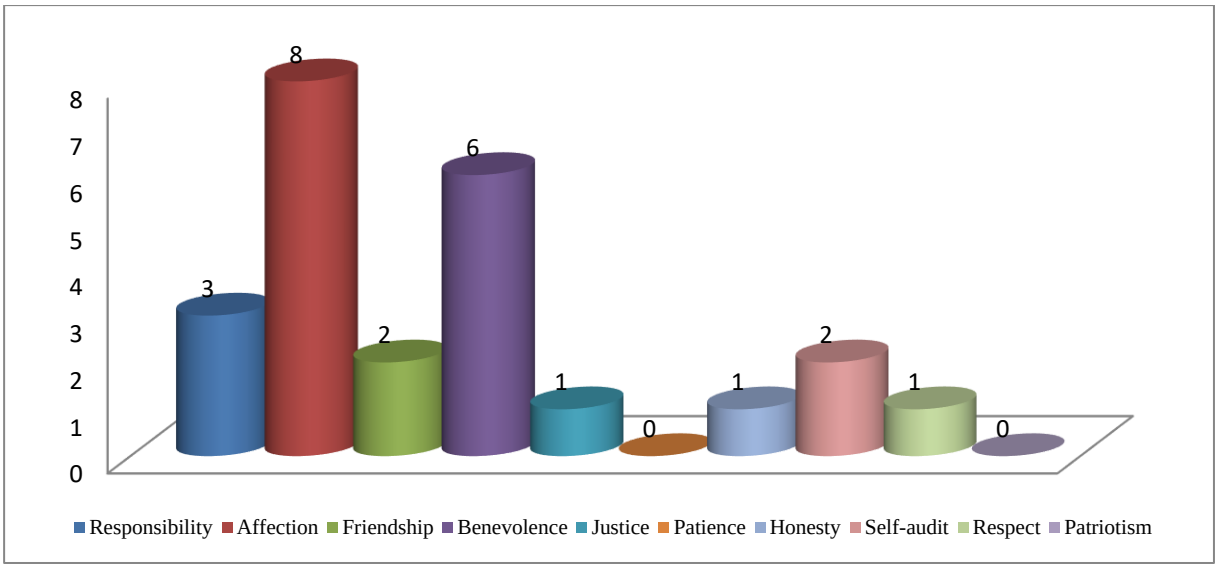


Figure 15 Values in the eighth grade mathematics textbook

According to the frequency graphic of the values in the eighth grade mathematics textbook, the most common value in the textbook was the value of love, with 8 (33.3%). The value of love is followed by the values of benevolence with 6 (25%), responsibility with 3 (12.5%), friendship and self-control with 2 (8.3%) each, and justice, honesty and respect with 1 (4.2%) each. The textbook found no expressions containing the values of patience and patriotism. An example of the value of benevolence in the eighth grade mathematics textbook is presented below.

10. Doktor, Ayşe Nine'ye yazdığı ilaçlardan birini 8 saat, diğerini 12 saat arayla içmesini söyledi. Komşu Suzan Hanım, Ayşe Nine'ye ilaçlarını içeceği saatleri söyleyerek yardımcı olmaktadır. Ayşe Nine, ilaçlarını sabah saat 08.00'de birlikte aldığına göre; **a.** Suzan Hanım, en erken saat kaçta iki ilacını birlikte almasını söyleyecektir? **b.** Ayşe Nine, ikinci kez ilaçları birlikte aldığı zamanda 8 saatte bir aldığı ilaçtan kaç kez almış olur?		The doctor told Grandma Ayşe to take one of the medicines he prescribed 8 hours apart and the other 12 hours apart. Mrs. Suzan, the neighbour, helps Grandma Ayşe by telling her when to take her medicines. Since Grandma Ayşe takes her medicines together at 08.00 in the morning, a. At what time at the earliest will Ms. Suzan tell him to take his two medicines together? b. When Grandma Ayşe takes the medicines together for the second time, how many times does she take the medicine every 8 hours?
Turkish		English

Figure 16 The value of benevolence in the eighth grade mathematics textbook

In the exercises section of Unit 1 (p. 25) of the eighth grade mathematics textbook, neighbour Suzan Hanım is helping Grandma Ayşe take her medicine can be an example of benevolence's value.

Findings related to the fourth sub-problem of the study

In the fourth sub-problem of the study, the findings regarding the distribution of root values in middle school mathematics textbooks according to learning areas are given in Table 6.

Table 6 Distribution of values in middle school mathematics textbooks according to learning areas

Fifth Grade		Sixth Grade		Seventh Grade		Eighth Grade	
Learning Area	f (%)	Learning Area	f (%)	Learning Area	f (%)	Learning Area	f (%)
Numbers and Operations	32 (61.5)	Numbers and Operations	23 (74.2)	Numbers and Operations	13 (40.6)	Numbers and Operations	6 (25)
Algebra	- -	Algebra	0 -	Algebra	11 (34.4)	Algebra	11 (45.8)
Geometry and Measurement	9 (17.3)	Geometry and Measurement	5 (16.1)	Geometry and Measurement	3 (9.4)	Geometry and Measurement	1 (4.2)
Data Processing	11 (21.5)	Data Processing	3 (9.7)	Data Processing	5 (15.6)	Data Processing	2 (8.3)
Probability	- -	Probability	- -	Probability	- -	Probability	4 (16.7)
Total	52	Total	31	Total	32	Total	24

When Table 6 is examined, the fifth grade mathematics textbook values are mostly included in the learning area of numbers and operations with 32 values (61.5%). The numbers and operations learning area is followed by data processing with 11 values (21.5%), and geometry and measurement learning areas with 9 values (17.3%). Since there are no algebra and probability learning areas at the fifth grade level in the curriculum, no values were determined for these learning areas.

The values in the sixth grade mathematics textbook are mostly in the learning area of numbers and operations, with 23 values (74.2%). The learning area of numbers and operations is followed by geometry and measurement with 5 values (16.1%) and data processing with 3 values (9.7%). Since there is no probability learning area at the sixth grade level in the curriculum, no value determination was made for this learning area. In addition, no value statement was found in the algebra learning area at this grade level.

In the seventh grade mathematics textbook the values in the seventh grade mathematics textbook are mostly included in the learning area of numbers and operations with 13 values (40.6%). The learning area of numbers and operations is followed by algebra with 11 values (34.4%), data processing with 5 values (15.6%), and geometry and measurement with 3 values (9.4%). Since there is no probability learning area at the seventh grade level in the curriculum, no value determination was made for this learning area.

The eighth grade mathematics textbook values are mostly in the algebra learning area, with 11 values (45.8%). Algebra is followed by numbers and operations with 6 values (25%), probability with 4 values (16.7%), data processing with 2 values (8.3%), and geometry and measurement with 1 value (4.2%).

Conclusions and Suggestions

This study was conducted to examine the content of primary and secondary school mathematics textbooks in terms of root values and to determine the extent to which root values are included in the textbooks. In mathematics textbooks at the primary school level, the textbook with the highest number of value statements was the first grade textbook. The first grade textbook is followed by the second grade textbook, and then the third grade textbook. The mathematics textbook with the least value statements was the fourth grade textbook. This shows that as the grade level increases in primary school mathematics textbooks, the value expression given in the book decreases. This may be due to the fact that as the grade level increases, the number of objectives to be given in the mathematics curriculum tends to increase or the subjects become more difficult. A similar finding was obtained in another study examining primary y school mathematics textbooks. In their study, Uzunkol and Karaca (2019) found that third grade textbooks included more root values than fourth grade textbooks.

When mathematics textbooks at the secondary school level were analysed in the study, the textbook with the highest number of value statements was the fifth grade textbook. The fifth grade textbook is followed by the seventh grade textbook and then the sixth grade textbook. The textbook with the least value statements was the eighth grade textbook. This shows that the values in middle school textbooks are not organized according to grade level, unlike those in primary school textbooks. This result coincides with the study results (Teker & Ellez, 2022) in which root values in high school mathematics textbooks were examined. In this study, the ratio of root values in high mathematics textbooks to the book's entire content was calculated. The study found that the ratio of root values to content was highest in the tenth grade textbook, followed by the ninth grade textbook. The ninth grade textbook was followed by the eleventh grade textbook, while the twelfth grade textbook had the lowest rate. On the contrary, in another study (Özdemir, 2023) in which secondary school science textbooks were examined, it was found that the fifth grade textbook included the highest number of root values, the eighth grade textbook had the lowest number of root values, and the values included in the textbooks decreased inversely as the grade level increased.

In addition, the most common value in the mathematics textbooks at the primary school level in the study was the value of responsibility. This value is followed by the value of respect and the value of benevolence. The least common value in primary school mathematics textbooks is honesty. Responsibility value is included in textbooks more than other values to increase students' awareness of themselves, their families, and their environment and instil in them that their behaviours can have significant consequences (Özdemir, 2023). Kılcan (2020) examined secondary school mathematics textbooks and found that responsibility was the most common root value. In another study, Akıncı and Yıldız (2023) examined the textual and non-textual elements in four different mathematics textbooks at the secondary school level. They found that the most common value in these books was responsibility. Şahin and Başgül (2018), in their study examining the values in middle school mathematics textbooks, stated that the most common value in these books is responsibility. In another study, Teker and Ellez (2022) concluded that the most common values in high school mathematics textbooks were benevolence, responsibility, and patriotism. In this context, since the value of responsibility is one of the prominent values in these studies, it is similar to the result of our study. In secondary school mathematics textbooks, the most common value is love. The least common value in secondary school mathematics textbooks was found to be the value of respect. This coincides with the results of some studies in the literature. Horzum and Yıldız (2023) examined secondary school mathematics textbooks. While responsibility and love were the most emphasized root values in textbooks at all grade levels, honesty and respect were the least emphasized root values compared to other values. In other studies, overlapping with this result, Uzunkol and Karaca (2019) and Kılcan (2020) stated that the root value of respect was one of the least common values in the textbooks they examined and that these root values were included less than 5% of the time.

When the most common values in mathematics textbooks were analysed according to grade levels, the most common root value in the first grade mathematics textbook was the value of responsibility. In the second grade, the most common root values were love and self-control, and in the third grade, the most common root value was responsibility. The root value most frequently included in the fourth grade textbook was the value of responsibility. This situation reveals that the value of responsibility is emphasized in mathematics textbooks at the primary school level. This result is in line with the results of the studies in which Science textbooks (Yılmaz & Kıran, 2023), Geography textbooks (Aydın, 2019), Physics, Chemistry, and Biology textbooks (Koltaş, 2020), Turkish textbooks (Derse, 2019) were examined. In the

textbooks analysed in these studies, responsibility was the most common value in the textbooks. In mathematics textbooks at the secondary school level, the root value most frequently included in the fifth grade was the value of love. The most common root value in the sixth grade was friendship, while the most common root value in the seventh grade was responsibility. The most common root value in the eighth grade textbook was the value of love. This shows that the most common value in mathematics books at almost all grade levels in primary and secondary schools is love or responsibility. This result is similar to Şahin and Tuğrul's (2020) finding that love is the most common value in primary school textbooks. In studies in the literature (Eken & Öksüz, 2019; Hazım, 2019; Özkan, 2017) in which textbooks in different branches were examined, the value of love is one of the most frequently encountered values. The frequent occurrence of the values of love and responsibility in the analysed textbooks is important in terms of instilling these values in students. Children's awareness of their responsibilities enables them to become individuals who try to fulfil their duties on time and accept the consequences of their behaviours (Yılmaz & Kıran, 2023). Instilling the value of love in children from an early age will enable them to be good individuals towards their environment, friends, nature, and family. Because love is at the beginning of every good deed.

When the least common values in mathematics textbooks were analysed according to grade levels, the least common values in first grade mathematics textbooks were self-control, justice, and love. The expression, including the value of honesty, was not found in the first grade textbook. From this situation, it can be concluded that self-control, justice, and love values were not given enough importance while preparing first grade textbooks, and honesty value was not given any importance at all. The absence of these values in first grade textbooks may pose a problem. Because not including root values in the textbook creates a gap in their teaching (Horzum, & Yıldız, 2023). However, including all root values in the first grade mathematics textbook, which is the first year of primary education, is important for teaching these values and the continuity of this teaching. When the mathematics textbooks at other grade levels were analysed, it was found that the least common values in the second grade were justice and honesty, the least common values in the third grade were honesty and respect. The least common values in the fourth grade were friendship and justice. As can be seen, no attention was paid to a homogeneous distribution of root values in the textbooks. This situation shows that there is no directive or standard for values during the preparation of textbooks (Akıncı & Yıldız, 2023). However, setting a standard and including all root values

in the textbooks in equal or close numbers will prevent a separation between root values and emphasize that all root values are equally important (Özdemir, 2023). In their study, Kuş et al. (2013) also stated that values should be reflected in course materials regularly and consistently.

If we consider mathematics textbooks at the secondary school level, the least common root values in the fifth grade were respect; in the sixth grade, the least common root values were honesty, respect, and patriotism; in the seventh grade, the least common root values were patriotism and honesty; and in the eighth grade, the least common root values were justice, honesty, and respect. This situation reveals that some root values are not sufficiently included in some grade level books and that the contents of the books do not show a homogeneous distribution in terms of root values. In other studies, examining secondary school mathematics textbooks (Horzum, & Yıldız, 2023; Kılcan, 2020), it is stated that the content does not show a homogeneous distribution in terms of values, but the values included in the books are heterogeneously distributed. The situation was similar in a study examining high school mathematics textbooks. Çetin et al. (2021) examined ninth grade mathematics textbooks and found that patience and honesty were less common than other core values. In addition, they stated that this situation posed difficulties in terms of reinforcing values and ensuring continuity.

In addition, in this study, no expressions, including the values of patience in the sixth grade mathematics textbook, justice and respect in the seventh grade mathematics textbook, and patience and patriotism in the eighth grade textbook were found. This shows that the content of these books is lacking in terms of some core values. This may be due to the fact that some values are not given enough importance and are ignored while preparing the books. In another study examining secondary school mathematics textbooks (Horzum & Yıldız, 2023), it was observed that the root value of honesty was not used in seventh grade textbooks, and the value of patience was not used in eighth grade textbooks. This situation reveals that some root values are difficult to teach in mathematics textbooks at the sixth, seventh, and eighth grade levels.

When mathematics textbooks are analysed in terms of learning areas, it is seen that the learning area in which values are most frequently included in the first grade mathematics textbook is numbers and operations. Numbers and operations learning areas are followed by measurement and geometry learning areas, respectively. It is understood that the learning area

with the least number of values in the book is the data processing learning area. It is seen that the values in the second grade mathematics textbook are mostly included in the learning area of numbers and operations. It was found that the learning areas of numbers and operations were followed by measurement and geometry learning areas, respectively. It is understood that the learning area with the least value is the data processing learning area. It is seen that the learning area in which the values in the third grade mathematics textbook are mostly included is the learning area of numbers and operations. While the learning area of measurement followed the learning area of numbers and operations, the learning areas of geometry and data processing were the least covered. It is understood that the section where the values in the fourth grade mathematics textbook are most frequently included is the learning area of numbers and operations. The learning area of measurement followed the learning area of numbers and operations, while geometry and data processing were the learning areas least covered in the book. In this direction, it can be concluded that the learning area in which values are most involved in all grade levels in primary school is the numbers and operations learning area. In contrast, the learning area in which they are least involved is the data processing learning area. This result is similar to the result that the “Numbers and Operations” learning area includes the most social values in elementary school mathematics textbooks (Şahin & Tuğrul, 2020). This may be because the content in the textbooks' numbers and operations learning area contains more examples of daily life situations compared to the content in the data processing learning area.

When mathematics textbooks at the secondary school level are analysed in terms of learning areas, it is seen that the fifth grade textbook contains the highest number of values in the learning area of numbers and operations. While the learning area of numbers and operations is followed by data processing, the learning area with the least number of values is geometry and measurement. In the sixth grade textbook, values are mostly included in the learning area of numbers and operations. The numbers and operations learning area is followed by geometry and measurement and data processing learning areas. It was determined that no value was found in the book in the field of algebra learning. It is seen that the learning area in which the values in the seventh grade textbook take place the most is the learning area of numbers and operations. The learning area of numbers and operations is followed by algebra and data processing. Geometry and measurement were identified as the learning areas with the least values. The eighth grade textbook's section with the highest number of values was determined as the algebra learning area. It was stated that the algebra learning area was

followed by numbers and operations, probability and data processing learning areas, and the learning area with the least value was the geometry and measurement learning area. In this direction, it can be concluded that the fifth, seventh, and eighth grade textbooks overlap with each other in terms of the learning areas with the least number of values, and that the highest number of values in all of these grade levels are in the learning areas of geometry and measurement. In addition, in all of the fifth, sixth, and seventh grade textbooks, the highest number of values is found in the learning area of numbers and operations. This result is the same with the primary school level textbooks. In the eighth grade textbooks, the highest number of value expressions was in the algebra learning area, followed by numbers and operations.

When the distribution of the values in the books within the framework of learning areas is analysed, it is seen that some grade level books show a regular distribution of values. In contrast, some grade level books show an irregular distribution of values. Teker and Ellez (2022) also stated in their study that the tenth grade mathematics textbook was created with a regular distribution in terms of values according to learning areas, but the values in the nineth, eleventh, and twelfth grade textbooks were distributed irregularly. In addition, in another study (Sayın et al., 2019), in which the fifth grade mathematics textbook was examined in terms of values, it was determined that the values in the book were inconsistently distributed. This situation is also supported by many studies that examined textbooks in different branches and reached similar conclusions that the root values included in the curriculum are not reflected in the textbooks in a planned, attentive, and healthy way (Calp, 2006; Ecerkale & Bayrak, 2018; Erbaş, 2021; Güçlü, 2019).

The following recommendations are presented as a result of the results and discussions reached in the study.

- The study's findings show that the root values in mathematics textbooks are not included in equal numbers according to grade levels, and some grade level textbooks include fewer values than others. Based on these findings, it is recommended that mathematics textbooks' content be made more comprehensive in terms of values and that sufficient importance should be given to teaching values in mathematics textbooks at all grade levels.
- The mathematics textbooks examined in this study are the textbooks of some publishing houses distributed by MoNE, and it is recommended that mathematics

textbooks of other publishing houses distributed by MoNE should also be examined from the value context.

- Although there are studies in the literature examining textbooks in some fields in terms of values, examining the content of all textbooks at primary, secondary, and high school levels in terms of values will contribute to the field.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

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Research involving Human Participants and/or Animals

Ethics committee permission was not obtained since the study was based on document analysis.

İlkokul ve Ortaokul Matematik Ders Kitaplarının Kök Değerler Açısından İncelenmesi

Özet:

Bu çalışma, matematik ders kitaplarının öğretim programında yer alan kök değerler bakımından incelenmesi amacıyla yapılmıştır. Bu amaçla 2022-2023 eğitim-öğretim yılında ilkokul ve ortaokullarda okutulan 8 adet matematik ders kitabı kök değerler bakımından incelenmiştir. Çalışmada nitel araştırma yöntemlerinden doküman analizi yöntemi kullanılmıştır. Belirlenen ders kitapları araştırmacılar tarafından ön okumaya tabi tutulmuş ve değer ifadesi barındırdığı düşünülen ifadeler belirlenmiştir. Çalışmada, ilkokul matematik ders kitaplarında kök değerlerin sayısının sınıf seviyesi yükseldikçe azaldığı görülmüştür. İlkokul ders kitaplarında en fazla sorumluluk değerine, en az dürüstlük değerine yer verilmiştir. Ortaokul matematik ders kitaplarında da kök değerlerin sayısı sınıf seviyesi yükseldikçe (6. Sınıf hariç) azalmaktadır. Ortaokul ders kitaplarında en fazla bulunan değer sorumluluk ve yardımseverlik değerleri iken; en az bulunan değer saygı değeridir. Bu sonuçlara göre ilkokul ve ortaokul matematik ders kitaplarında daha fazla sayıda ve çeşitte değer ifadesine yer verilmesi ve bu değerlerin sınıf seviyelerine ve değerlere göre eşit oranlarda dağılım göstererek ders kitaplarının hazırlanması önerilmektedir.

Anahtar kelimeler: Matematik ders kitabı, ilkokul, ortaokul, kök değerler.

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Research Article

Reasons for Wattpad Use in Turkey

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Abstract – This study was carried out to determine the reasons why users use Wattpad in Turkey. The benefits and harms of Wattpad content and the factors that motivate readers here are important for determining the methods to implement when using this platform. The study was designed as a case study as a qualitative research method. As a data collection instrument, interviews with writers and readers were conducted. Additionally, various documents and a research diary were used. Peer evaluation, member check and role-ordered matrix methods were used to analyze data and create categories. According to the content analysis results, the reasons why users use the Wattpad platform were determined to be the desire to be popular, interaction, ease of use, subjects, and language. The reasons for users to use the platform are collected and addressed in the Results section under the headings of sense of belonging and quest for meaning.

Key words: Wattpad, Wattpad usage, online story sharing.

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Introduction

Wattpad is a virtual storytelling and writing platform. The platform was founded in Canada in 2008 by Allen Lau and Iven Yuen, and more than 350,000 interactive stories have been shared on the platform as of 2019 (Wattpad, 2019). It has more than 80 million active monthly users worldwide, and Turkey comes after the United States and the Philippines among the countries where the platform is used the most (Kara, 2015). Generations Z and Y constitute 90% of the users on Wattpad, which supports more than 50 languages. A large 90% of Wattpad users access the site via mobile devices (Wattpad, 2019). The vision of Wattpad is

to entertain and connect the world through stories. The platform uses the power of communities and technology to create and distribute content in a variety of ways. Wattpad is a virtual environment that allows its users to express themselves, engage in social interactions, and develop literacy skills. It also allows its users to participate in a large-scale chat environment about current topics. There are 3 million Wattpad users in Turkey and about 7 million Turkish stories have been published on the platform. Many of the writers' stories have been published as books, as well as film and TV scripts. Although Wattpad has just become popular in our country, it is followed with great interest by a very large audience.

Problem Status

One of the issues addressed in this study is the discussion of the content readers read on Wattpad. Wattpad includes stories on common subjects such as science fiction, fan fiction and adventure, as well as many marginal topics such as young adults, vampires, zombies, werewolves, spiritual topics, drugs, mafia, and mysticism. In recent years, the number of violent contents, books, and games in children's publications around the world has been increasing. For example, works in children's literature include books that evoke violence such as the Curse of the Dragon, the Castle of Death, Paranormal Activity, Masochist, Suicide Notes, Screams of Violence (Tokat, 2022). There are opinions that such expressions bring harms which can lead to deviant beliefs, depression, and mental illnesses (Bonelli et al., 2013). Despite age restrictions on access to stories, Wattpad has been criticized, for example, for allowing anyone to read any subject they want, including subjects such as substance use, immorality, violent tendencies, etc., and for Wattpad providing examples of such subjects". Green Crescent (2017), for example, has warned families about Wattpad stories, claiming that Wattpad is harmful because subjects such as substance use, smoking and alcohol addiction, antisocial behaviors, cutting tools and firearms handling, tendency for sexual violence, driving without a driver's license, depression, disobeying school rules, absenteeism, and irregular eating and sleep habits that are depicted in stories in the most acclaimed Wattpad books can trigger and encourage risky behaviors among adolescents. In 2019, a study published by the Communications Directorate of the Presidency of the Republic of Turkey, entitled "The Use and Harms of Wattpad, which is becoming common in Turkey," stated that there are many stories on Wattpad that have a serious impact on the minds of young people and that the normalization of heathenism and immorality is propagandized in these stories.

Literature Review

Social media are customizable virtual environments where users meet virtually, interact with each other, and share stuff. Fruchter (2010) identified five features that make an environment social media: communication, community membership, commenting, collaboration, and user input (Piancola et. al., 2020; Santa Maria et. al., 2022). With these features in mind, as a platform where users and writers communicate with each other and comment on each other's posts, Wattpad is a strong social media tool that allows for sharing and enables writers and readers to meet in the same environment. A study by Contreras et. al., (2015) explained how people started reading on Wattpad, why they went on, and why readers became addicted to a story. They categorized the factors that led participants to read on Wattpad in six themes: people living in the environment, interest in literature, social media, boredom, free cost, and convenience. They also identified factors that motivated participants to keep reading on Wattpad as learning satisfaction and emotional satisfaction.

In addition to studies determining the effectiveness of Wattpad use in education, there are studies on identifying user experiences. Bal (2018) carried out a phenomenology study to identify in- and out-of-school reading and writing experiences of middle school students. The study used semi-structured interviews, and stories and journals written by students. Participants said they had a negative perception of reading and writing within the school because they were restricted and under pressure. On the other hand, they described the Wattpad platform as a place where they could express themselves comfortably. Bal (2018) claims this perception stems from the intrinsic sense of satisfaction and importance that students feel from using Wattpad. Moreover, the reason behind the participants' positive perceptions of reading and writing outside of school was identified as a desire to be popular. Aytan (2017) analyzed preservice teachers' electronic writing experiences in the Wattpad environment. Preservice teachers in his case study sample joined Wattpad and wrote at least one narrative text and one informative text within a month. They found writing electronically advantageous in terms of readability, spelling control, reader and writer interaction, visual appeal, time saving, convenience, affordable price, quick feedback, constructive criticism, encouragement, archival possibilities, and socialization, and indicated that writing electronically can be harmful in ways such as the untrustworthiness of the virtual world, distraction, fierce criticism, health, expression, sociality, copyright and plagiarism concerns.

There are also studies in the literature that sociologically examine the reasons why Wattpad is read. People, who take on distinct social roles in different stages of life that can be defined as youth, middle age, upper-middle age, and old age, display distinct behavioral patterns. High school students are involved in various behavioral tendencies especially when they are depressed (Demir et. al., 2005). When they move to higher education, this interest decreases due to adolescence. Unlike their everyday behavior, people act more courageously in the virtual world (Dogan & Karakus, 2016). Similarly, their more violent and aggressive reactions to events and what they read can be explained by the fact that they do not receive any reactions from society. The reasons for the use and effects of social media tools and user behavior in social media differ from culture to culture. Young and Young (2017) studied if social media use was related to gender-related adolescent motivations and online aggression behaviors. Results from that research on young adults demonstrate that social media use, romantic motivations, social belonging motivations and social comparison tendencies are associated with online aggression victimization. They also pointed out the importance of further examination of interactions and indirect effects in terms of the determination of other variables for the use of social media and determination of reflections in different cultures. In cultures where Wattpad use is very common just like in our country, the occurrence of similar reflections in different cultures can be observed by doing studies on this issue.

Method

Research Design

In this qualitative study, a case study approach was implemented. It is crucial to ask what the situation is in the case studies in order to select a meaningful unit of analysis and focus on the phenomenon in question (Patton, 2014). In this context, situations such as the sociological dimension of Wattpad influencers, their fan bases, and digital cultures were determined during the study but were excluded from the study. The study was designed as a single case study, where the drives that directed users to use Wattpad and motivated them to continue reading on Wattpad were framed as the case. The conduct of a case study necessitates extensive resources and time beyond the options available to a single student or an independent researcher (Yin, 2009). For this reason, extensive data were collected, the study was carried out in a comprehensive manner, and the data were subjected to an in-depth analysis. The preparation, implementation, and analysis of data collection tools took place over a four-month period.

Participants

Snowball sampling method was used to select participants. First, a college student named B was reached on Wattpad. Then a Wattpad reader named K, the roommate of that writer, was reached. Following that, K who was a Wattpad reader introduced the researcher to two Wattpad readers G and S, classmates of K. L, a student at the university where the researcher was studying, was also found to be a writer during a course and was included in the participants. In the end, in-depth interviews with two Wattpad writers and three Wattpad readers were conducted. Wattpad identities (as a reader/writer) and their initials were used to refer to the subjects in the study.

Data collection

Data to be used in case studies are obtained by bringing together all information from interviews, observations, documents, and different data sources that can provide information about the case (Patton, 2014). In this study, interviews, a research diary, and documents were employed as data collection instruments.

Interview Form

Semi-structured interview forms were used in the study. Interviews were conducted online at the time desired and determined by the readers. During the preparation of interview forms, experts were consulted, and a reader was interviewed beforehand. The interview form was finalized after final corrections. To conduct the interviews, sub-questions were also created and used as necessary throughout the conversations to understand the actual factors that directed users to write and read. Throughout the interviews, it was observed that the readers and writers answered the questions bravely, did not hesitate to respond to the interview questions regardless of whatever they read or wrote and defended what they read by giving examples of their lives.

Documents

In order to get to know Wattpad stories better and to learn the opinions of the writers, four interviews with Wattpad writers that had been posted on the Internet were analyzed. The names/nicknames of the writers who were interviewed with were Sedef Nehir Erdem, Büşra Yılmaz, Semiha Kaya and Eleştirmen. In the study, the names of the writers were represented as Writer S, Writer B, Writer K, and Writer T respectively. An interview with two publication editors who published Wattpad stories as books were examined to learn the opinions of the

world of publishers about Wattpad writers and readers. The first of the interviews was conducted by Borekci (2015) on July 26 with the publisher Özlem Esmergul. The other interview was conducted by Gozay (2016) on July 6 with the editor-in-chief Meltem Erkmen. In the study, the editors in these interviews were referred to as Editor M and Editor E, respectively.

Research Diaries

The researcher kept a diary from his meeting with the first Wattpad reader to write about what he experienced throughout the study and about the readers. A total of 8 journal entries were written from time to time throughout the three-month period. In addition, the researcher signed up for Wattpad in the process and logged his thoughts on the platform in the diary. Journals were stored on the researcher's computer and archived based on days, months, and hours.

Data Analysis

It is important to compare and confirm the findings that emerge during data analysis and to highlight significant interpretations in order to adequately understand specific behaviors of people in case studies. The content analysis method was preferred to analyze the data collected during the study and to create themes. Peer debriefing, member checking, role-ordered matrix and triangulation methods were used to ensure validity and to explain the case without any bias.

The information provided from each data source was combined to understand what it meant to be inside Wattpad. After the analysis of the interviews, all other data were transferred to the Microsoft Excel program, and themes and sub-themes were created separately for each participant and data type in a table. The role-ordered matrix was used to create codes, categories, and themes. The data collected were organized according to the following roles: writers, readers, and publishers. This made it easier to compare the organized data. By using the role-ordered matrix, it was checked whether the users saw the Wattpad platform in the same way, and making comparisons between the roles became easier (Miles & Huberman, 1994, p. 122). Wattpad is "a source of motivation" for writers, and according to the editors, "it is easy to be famous now." Under the theme of popularity, for example, these two claims were compared.

Validity and reliability

Triangulation was implemented by selecting multiple data collection instruments, and an attempt was made to improve the validity of the study by analyzing different sources. Three experts and the participants were interviewed to determine the consistency of the themes created and to be able to make conclusions from these codes. In these interviews, the consistency of themes, the biases of the researchers, vague and unnecessary explanations, and the accuracy of comments were reviewed and corrected. Through member checking, an attempt was made to improve the validity of the study. The participants and the researcher met with a variety of experts to review the findings and discussed the accuracy of themes. The reliability of the qualitative analysis was tried to be improved by including the participants in the analysis of data and the creation of the results (Creswell & Miller, 2000).

Results or Findings and Discussions

Why are Wattpad stories favored so much in Turkey, based on all these analyses and evaluations? The answer to this question is explained in this section based on the objective assessment of the Wattpad stories, interviews and document analyses and the examination of the results. The interviews conducted and the documents examined were evaluated by using various analysis methods. The categories, codes, and their descriptions uncovered as a result are presented in Table 1. According to the analysis results, the reasons for Wattpad use were the desire to be popular, interaction, ease of use, subjects and finally language.

Table 1 Categories Based on Analysis

Category	Code	Definition
Desire to be popular	Desire to be a writer	Users' desire to write
	Desire to be liked	Number of followers on Wattpad, desire to publish text as books
Interaction	Writer-Reader	Readers being able to comment about stories under the stories
	Reader-Reader	Readers' communication between themselves
	Writer-Publisher	Publishers' being able to access writers through Wattpad
Ease of use	Mobility	Users' being able to reach Wattpad through mobile devices
	Economy	Wattpad's being free
	Archiving	Publishing and archival of stories through Wattpad
Subjects	Interest in the dark side	(Mostly written subjects: love, fan fiction, young fiction, young girl literature, and bad boy)
	Marginal subjects	Reading twilight- and bad boy-like subjects
Language	Jargon used	Language used by Wattpad users
	Society and Culture	Cultural characteristics of Turkish society

Desire to be Popular

One of the reasons why users wrote on Wattpad was the desire to be a writer. The ultimate goal of the stories on Wattpad is to be able to be a book or be involved in a scenario-like production in another media outlet. Editor E expressed her observations on the subject as follows:

"I think Wattpad has begun to be seen as a way to be 'famous' and make some money. Everyone thinks they have a story to tell. There's also the belief 'He wrote it, why shouldn't I write it.' When people who have never been recognized suddenly became bestsellers and very popular, the act of writing became an attraction just like being singers and actors."

According to Editor M, the popularity of writing is used by young Wattpad writers with no literary background and style:

"People write without reading anymore. Writing books has become very popular in recent years, a whim. We also encounter some very interesting suggestions like 'I can write very nicely, but can you tell me something to write about?'"

In her interview, Writer S was asked, *"Was writing a TV series script part of your future plans or was it an offer that was made to you?"*. She replied, *"One day I got a message. Ferda Eryılmaz asked me, 'Do you want to write a script and work with me?'"* and she said that she felt great excitement. It is a great source of motivation for writers if their stories are published as books or become movies or TV series through Wattpad and if Wattpad introduces them to the media.

Interaction and Ease of Use

Reader–writer interaction is one of the most important elements in Wattpad. Wattpad makes it possible for writers and readers to text each other and share information, for users to follow each other, and for readers to comment on every sentence of stories. Writers' having readers and having a certain number of followers are among the criteria for the publication of stories as books (Editor E):

"Followers and comments, actually. At first, of course, we all considered followers, because it was an area we never knew about. But the rate of followers can be deceiving. Comments, private forums, and reader orientations are also important. We also frequently receive writer recommendations via e-mail and Facebook. You need to keep a close eye, read,

communicate with them all the time, listen to them, and many of them are actually very close friends. It's a situation we're not used to, it's a very interactive area."

Readers' comments are also of great importance for the technical improvement of the stories. Wattpad's in-line comment feature allows readers to see how they respond to the story. Readers pass on the spelling mistakes made by the writers they love in comments about the stories to the writers. There are also critics who technically examine Wattpad stories. Consequently, Wattpad offers a good interface for editing stories and for writers to technically enhance themselves. *"I'm thinking of continuing to develop my story because of the messages I receive,"* says Writer B, who thinks that Wattpad is one of the biggest sources for her to improve and motivate herself.

Wattpad interface offers many advantages such as writing and sharing stories, meeting with readers, and giving the opportunity to comment on text. About a platform where users can step towards becoming authors, Writer B commented: *"I can make a classic sentence like 'a world at my fingertips.' Being famous, popular... It's all at your fingertips."* According to the participants, Wattpad's opportunity to write, archive and publish text through its mobile app prevents them from forgetting what the muse says at certain times. Writer B: *"A desire arises within you to write in an unprecedented time in an environment you've never been in. That's why I prefer the phone, because it's with me all the time, it's easy to access."*

Moreover, the use of technology to correct the stories written and to remove spelling mistakes provides great convenience. Writer B: *"I'm a person who modifies what she writes all the time. So, it's harder for me to write on paper, but it's much easier for me to change and update when I write digitally,"* she said. One of the reasons why readers prefer Wattpad can be said to be that it is free, and it is easy to read on mobile devices.

Subjects

As seen in Table 1, the stories written on Wattpad were mostly written on the subjects of love, fan fiction, young fiction, young girl literature, and bad boy. Most writers aimed to make analogies in representations, as well as differences in meaning in words and phrases. Especially by having mistakes in sentences and using meaningless sentences, they, in a way, came up with a new style. Editor M spoke the following about the subjects found on Wattpad:

"A very large part of them are Twilight readers. Interestingly, there are also those influenced by Fifty Shades of Gray. And then there's an audience that mostly grew up with

children's classics and children's books, and now tries to decide what to read. But they predominantly read fantastic books and are influenced by young adult influencer books."

According to Editor E, the marginality of the subjects written causes writers to hide their stories from their families:

"I once contacted a writer who's been read a million times on Wattpad. He was so excited, he got happy and immediately wanted to sign a contract. So, I invited him here with his parents and told him we could only do the contract with them. He panicked; he was a student at an imam hatip high school. He was afraid his father, a conservative man, would be angry because the book contained +18 items."

Wattpad stories cause authors to hide content, as well as causing readers to hide stories they read from their families. *"When you notice your child or student reading stories on Wattpad, he or she may have already finished 5-6 books"* (Research Diaries, 2018, p. 2). In the virtual realm of stories, young writers who are afraid and anxious become secret personalities. This is another feature that can be said to attract users to the Wattpad environment.

Language

The language and style of written stories are another feature that makes Wattpad stories interesting in the light of the findings. Rich and thought-provoking words, difficult expressions and events, and complex sentence structures are thought to be intriguing to readers. Writer B says:

"I don't establish short, ordinary sentences like 'I went over there, I've come from there.' I'm transferring the character's feelings to the essay like a poetry. Of course, this is not heavy on language — not as un-understandable — as the Ottoman writers did. I'm doing something that everyone will be able to understand even when they read it for the first time, but the sentences they read will dance around their heads. I'm writing a story the way I want to read it."

In Wattpad, stories that are simple and full of grammatical errors are predominant, and those that we can describe as fictionally weak too. The stories to be published as a book, on the other hand, go through a long editing process. Nevertheless, the grammar structures in stories are not very important to readers. Readers do not care about or dislike the mistakes and fictional problems of the writings they read on Wattpad. Reader K: "I find it normal because, per the age and books written, they use a normal language." As a matter of fact, in comments

of stories, readers share with writers the parts they consider wrong with great dedication. In this context, it can be said that Wattpad users have their own digital culture. Editor E voices a different interpretation of stories:

"These guys — who write with their own styles and jargons as they wish and do not obey any literary rules —, I believe, give their brothers and sisters the courage to go beyond stereotypes, who dream of writing books. They buried the rules in textbooks. They don't care about language and narrative rules, nor do they care about the dictionary of Turkish Language Association (TLA)... They have taken the risk of freely creating literature without any literary concern."

Conclusions and Suggestions

One of the most basic needs of mankind is the quest to make sense of life. People's ability to have a world of meaning depends on their being together with their fellow human beings, i.e., being in a social relationship. It can be said that people are less in touch with each other, and that human relationships are colder in the 21st century. In recent years, however, the values and ideas of young people have changed to scientific-mystical works that have become more popular due to Harry Potter books and accelerated with Wattpad stories. Young people who are in search of making sense of the world through Wattpad stories are offered a sense of mysticism. Generation Z seeks to make sense of life on various platforms, overwhelmed by the uncertainty of the rules set by their families, traditions, religions, politics, and so on (Ulu, 2018).

Why are these mystical subjects on Wattpad being read too much, and why are we having trouble understanding them? Behaviors and reading cultures of Wattpad users, which are not accepted by their parents, educators, and rule makers, may be caused sociologically by their desire to disobey the rules. Considering the findings of the study, users' desire to break the rules can be explained by the stage of development of young people and the impact of the social structure on them. Adolescent users, who constitute ninety percent of Wattpad users, are known to behave in ways that push the limits, disobey rules, and so on. In the course of identity confusion, people who have to gain their self-identity attempt to adapt to the world of adults by making unlimited experiments of assuming roles (Kurt & Yildiz, 2017, p. 210). During this psychosocial crisis, people who generally reject their family, cultural structure and society are dragged around by different ideologies, such as different quests and free decision-making to how to behave. We can say that these behaviors manifest themselves as a

desire to follow marginal writers and write stories on different marginal issues on Wattpad. As also mentioned in the findings, young adults may tend to get ideas from a writer who they think they can get advice from about their goals, expectations, indecisions at this stage, who they see closer to themselves, who is in the same age group as themselves, and they may tend to trust him or her more than they trust anyone else.

Changes in economic, legal, political, and religious structures in the world can also have a variety of effects on human behavior and lead to disagreements between generations. As everyone knows, generations X and Y, and generation Z speak a different language. While the subjects they read are mystical to us, the vague and unsatisfactory advice we give them, the behaviors that we do not do but want them to do, are mystical to them. In a sense, young people seeking to make sense of life are offered platforms that can replace religion and science. The emptying of the content of the concepts of religion and science in our age draws the young generation in search into spiritual, mysterious, and dark subjects. Reading the life of a zombie or watching the Walking Dead is more satisfying for Wattpad users and more responsive to their search for meaning in their lives. This psychological and sociological dimension is mentioned in many important literary works such as ‘God of Flies,’ ‘Rhinos,’ and ‘Foreigners.’ The next generation’s thoughts on fulfilling the moral norms of society can be said to have changed, which supports the opinion of teachers, families, and the great majority.

In the past, people would stick to a religion, a teaching, a cause, or a human being, and they would live accordingly. People tend to be a member of a group — even if it is a small group — and establish close relationships with people. The new generation, however, does not want to be part of a circle, as mentioned above, does not want a boundary drawn on them. These young people are thought to have a weak sense of belonging. The fact that these young people, who do not want to stick to a sense of belonging, scream around a writer they do not know and parade around book fairs shows us that young people do actually have a sense of belonging. As a result, it can be said that there is a virtual bond of belonging among users who do not know each other at all and who have thousands of miles between them (Elitas & Keskin, 2014). If the need to belong to somewhere, one of the normal needs of people during their lifetime, is not fully met or prevented, this can cause psychological problems, early marriages in some cultures, and traumatic events. Perhaps the most moderate of these consequences is that young people’s friendship relationships lack a satisfaction factor, which leads young people to the digital world where their skills are better. In this sense, Wattpad

plays the role of the most critical regulator of users' surreal relationships and plays a role in their sense of self growth (Parnell, 2021; Ramdarshan Bold, 2018).

Reading holds a central importance in the formation of participants identities, and Wattpad expands their reading opportunities and networks (Loh et. al.,2023). The events people experience, and the words told to them in the process of self and personality development may push them to suppress some of their emotions. One of the factors that motivates users to write on Wattpad is their urge to write having been frustrated and devitalized in their past lives. Families, educators as well as publishers have a great share in this (Editor M):

"I think there's a place where we all — as publishers — make mistakes under the circumstances. We're very timid in accepting a file from a new writer. Consequently, countless young writer candidates were lost or discouraged. Wattpad is a chance in this sense, a very important channel in promoting young writers. There's a chance you'll capture your own audience and publish your book through a publishing house."

Young talents seek platforms where they can manifest themselves for similar reasons. Social media are ideal platforms for them. Pianzola et al. (2020) remarked on, due to its allowance for comments between lines, Wattpad is an exceptionally interactive platform. In addition, participants highly value the feedback they receive from their peers regarding the work they share (Santa Maria et al., 2022). The Wattpad~~'s~~ platform responds to common concerns of teenagers, such as spending time together, finding a place to express themselves, sharing their concerns and secrets, and getting away from a stressful family atmosphere (Demir et al., 2005). Young people's desires, such as a desire for integrity and a desire to be valued, are fulfilled by Wattpad-like environments, particularly social media. Wattpad writers' articulate feelings of their readers (peers). Writer T:

"What makes them different is that they use a language and a set of terms that are unique to them that only young people can understand. What are reflected in the imagination of young writers manages to appeal to the feelings of young people in high school age. They're looking at the world through a similar window, after all. The reflections of pangs of love and friendship relationships in their souls are close to each other's."

What will happen to Wattpad in the future and how it influences existing users' spiritual worlds are a topic of curiosity. A conclusion that can be drawn from this study is that Wattpad is a platform that encourages young writers, that what is observed at book fairs is temporary,

and that this resulting digital culture is not going to turn into an unenthusiastic trend. As a matter of fact, fan cultures have caused many tragic events on earth from the past to the present. Therefore, this digital culture is an issue that should be investigated in terms of sociology and psychology.

Compliance with Ethical Standards

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Research involving Human Participants and/or Animals

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Türkiye'de Wattpad Kullanımı Nedenleri

Özet:

Bu çalışmada Türkiye'de kullanıcıların Wattpad kullanım nedenlerinin belirlenmesi amaçlanmaktadır. Wattpad sanal ortamda hikâye yazma ve keşfetme platformudur. Wattpad yazarları Türkiye'de kısa sürede Z kuşağı olarak adlandırılan genç nesil tarafından sevilmiş ve büyük bir hayran kitlesine ulaşmıştır. Wattpad içeriklerinin fayda ve zararları, okuyucuları motive eden etmenlerin ve platformu kullanırken nasıl bir yol izleneceğinin belirlenmesi önemli bir ihtiyaçtır. Çalışma, nitel araştırma yöntemlerinden durum çalışması olarak desenlenmiştir. Veri toplama aracı olarak yazar ve okurlar ile görüşmeler gerçekleştirilmiş; ayrıca çeşitli dokümanlar ve araştırmacı günlüğü kullanılmıştır. Verilerin analiz edilmesinde ve kategorilerin oluşturulmasında içerik analizi, akran değerlendirme, katılımcı teyidi ve rol-sıralı matris kodlama yöntemleri kullanılmıştır. İçerik analizi sonucuna göre kullanıcıların Wattpad platformunu kullanma sebepleri, popüler olma isteği, etkileşim, kullanım kolaylığı, konular ve dil olarak belirlenmiştir. Sonuçlar kısmında kullanıcıların platformu kullanma sebepleri aidiyet duygusu ve anlamlandırma arayışı başlıklarında toplanmış ve tartışılmıştır.

Anahtar kelimeler: Wattpad, Wattpad kullanımı, çevrimiçi hikâye paylaşımı.

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Research Article

Positive Discourse Scale in Teaching: Validity and Reliability Study

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Abstract – In this study, it was aimed to develop a valid and reliable measurement tool to be used for third and fourth grade primary school students to evaluate positive discourse in teaching processes. For the study, an item pool was created by reviewing the literature on discourse and positive discourse. The prepared items were made ready after expert evaluations and a pilot application to students. After the scale was applied, exploratory factor analysis was performed within the scope of validity, and it was concluded that it had 4 sub-dimensions consisting of 25 items explaining 51% of the total variance. Then, confirmatory factor analysis was performed, and it was concluded that the chi-square value (χ 2/sd) was 1.87, SRMR value was 0.05, TLI value was 0.88 and CFI value was 0.9. It was found that the scale was compatible with this structure. At the same time, Cronbach Alpha value and McDonald's Omega coefficient were calculated in the reliability calculations of the scale. It was concluded that the Cronbach Alpha value for the whole Positive Discourse Scale in Teaching was 0.91 and McDonald's Omega coefficient was 0.91. It can be stated that the scale is a valid and reliable measurement tool for primary school third and fourth grade students. This scale was developed to enable primary school students to evaluate positive discourse. Considering the teaching process, a scale can also be developed for teachers to determine the level of student's positive discourse.

Key words: Positive discourse, scale development, primary school third and fourth grade students.

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Introduction

Individuals generally express their thoughts through language, and for this reason, it is important to understand the things that are said, what they mean and what is understood by

the other party. Of course, this situation manifests itself in every environment where individuals communicate. By moving away from the people they communicate with in their family environment and immediate surroundings from an early age, children begin to communicate primarily with their classroom teachers and new friends when they enter school. When considering education and training processes, the classroom is the environment where students and teachers share their knowledge and experiences through various means of communication in order to achieve educational goals (Bayraktutan, 2008). It is also an environment that facilitates conversations between teachers and students and among students themselves (Ramli & Yohana, 2015). Seen in this light, the classroom is full of discourses and dialogs, and discourse can be observed in the classroom and in conversations between students and teachers (Molinari & Mameli, 2010). Meaning is constructed also through discourse.

Teachers have an important role in the teaching and learning process, and the role that they have is dominant since they control learning goals, styles and activities. This role of teachers affects students' short and/or long-term learning (Kurhila, 2004). Therefore, it is of great importance to consider teachers' roles and communications in the classroom. Ellis (2008) argues that teachers modify and adapt the functions and forms of language to enhance classroom interaction and communication, and that their speech and roles enrich classroom discourse (as cited in Al-Smadi & Ab Rashid, 2017).

Discourse is any specific instance of communication between individuals and themselves or others, primarily through verbal or other symbolic systems (Sfard & Kieran 2001). The essence of discourse is the gestures, mimics, special codes and agreement on the use of words that enable communication (Uğurel, 2010). Accordingly, discourse is used for any group of spoken or written language that is longer than a single sentence (Cazden & Beck, 2003). Besides any meaningful use of language, discourse encompasses communicative gestures, as well (Gee, 1999), and is inextricably linked to the enactment of social activities (e.g., classroom lessons), the formation and maintenance of social identities (e.g., students as gifted learners), and interactions of social groups (e.g., classroom communities) (Otten, 2010).

Discourse does not only depend on the content of the message in the communication process, but also includes the speaker, authority, audience and purpose of a message (Çelik & Ekşi, 2008). According to Mc Closkey (2008), discourse constitutes reality with knowledge, practices, evaluations, judgments and beliefs. Thus, reflecting it to others by enabling the

world to be understood and perceived (as cited in Gür, 2013). Just as discourse directs interaction, teacher discourse directs classroom interaction in the teaching process. For this reason, a positive discourse will lead to a positive interaction, which will have a positive effect on the learning process (Abu Katılı, 2021).

Individuals create their first discourse environments with their family and social environment in which they were born and live. Later, the educational process that initiates their student life constitutes a very important discourse environment for them as well. Classroom discourse, closely linked to the academic and social development of individuals, is shaped by the diversity of discourse among students and between them and their teachers. As a result, positive discourses and discourse environments created by classroom teachers in primary school may have a greater contribution to students' learning, motivation and attitudes.

According to the theory of social constructivism, which assumes that learning is shaped by interacting with the social environment, it can be said that the discourses used by teachers in educational environments should support students. This perspective illustrates that positive discourse features should be used in educational environments. In educational settings, discourse refers to the conversation that includes both verbal and non-verbal exchanges between teachers and students in the classroom (Cazden & Beck, 2003). In this sense, Rymes (2008) argues that classroom discourse is the use of language to create interaction in order to carry out the learning process (as cited in Abu Katılı, 2021). Classroom discourse is the primary setting in which teaching and learning takes place, and when skillfully managed, it can provide an opportunity for students to develop their own understanding and benefit from the ideas of their peers and teachers (Wang et al., 2014). The process of "opening up" discourse in classrooms and making it more productive provides teachers with more opportunities to get to know and understand their students. Therefore, students need to participate actively in classroom discourse (Chi, 2009; Resnick et al., 2010). Classroom discourse also includes features such as interaction styles, teacher talk, and unequal power relations (Al-Smadi & Ab Rashid, 2017). Accordingly, teachers need to provide space for students to express their ideas, arguments, interests, and opinions about learning (Walshaw & Anthony, 2008; Weil et al., 2020). While students can learn from productive classroom conversations, teachers can learn about their students. Teachers can learn from their students' reactions both to their teachers and to their students' reactions to each other (Michaels & O'Connor, 2012). If teachers can actively engage their students in classroom discourse, they

are more likely to engage their students in more meaningful and sustained learning (Walshaw & Anthony, 2008).

According to Chapin et al. (2009), there are five teaching practices to improve the quality of discourse in educational processes. These are (a) talk moves to encourage students to discourse [Five Talk Moves (1. Revoicing; 2. Asking students to restate someone else's reasoning; 3. Asking students to apply their own reasoning to someone else's reasoning; 4. Prompting students for further participation; 5. Using wait time)], (b) the art of asking questions, (c) using student thinking to stimulate discussions, (d) setting a supportive environment, and (e) managing discourse. Revoicing, one of the five talk moves, involves the teacher revisiting some or all of the student's utterances and asking or prompting the student to question the accuracy of the information again (Garcia, 2009).The act of revoicing can allow the idea presented by one student to be used by other students and give them time to listen again (Chapin et al., 2009). When we look at the purposes of asking questions that can be addressed in the process of Paraphrasing, the teacher asks any student in the classroom to repeat or rephrase what other students have said. The act of asking students to answer their reasoning as if they were someone else is the Agree? or Disagree? Why? move, and the teacher asks the student whether he/she agrees or disagrees with what other students have stated or asserted in the classroom . Moreover, Prompting for Further Participation is when the teacher asks students questions about the topic in order to generate discussion and increase discourse in the classroom, and finally Using Wait Time refers to the time expected for students to respond when a question is asked in class.

The other teaching practice, the art of asking questions, is to ask appropriate questions depending on the cognitive level of the students. The teaching practice of using students' thoughts to stimulate discussion is to create a class discussion based on what students say and to ask questions about students' thoughts to expand the discussion. Creating a supportive environment is organizing the teaching environment (seating arrangement) to make the classroom environment more effective. The last teaching practice, managing discourse, is to encourage students to express their thoughts and increase student-student interaction.

National Council of Teachers of Mathematics (NCTM) (2000) recommends moving from a teacher-centered classroom to a classroom that focuses on student thinking and reasoning and the practice of managing classroom discourse. Therefore, teachers need to spend more time understanding how students think (Chambers, 1995; Hillen, 2006).

According to Shanefelter (2004), teachers can only truly understand what is going on in students' minds if students have the opportunity to articulate their thoughts (as cited in Hillen, 2006).

Hearing students talk about what they understood can help the teacher understand what students missed or did not fully understand. This will enable the teacher to fill the missing gaps, and by doing so, the concepts taught can be grasped more thoroughly (Huggins & Maiste, 1999; Hillen, 2006).

For this reason, in order to identify positive discourses in the educational process, the teaching practices described by Chapin et al. (2009) are taken as a basis. In addition, the studies in the national and international literature review [Smith et al, 2009 (on orchestrating classroom discussion); Sfard, 2000 (on communication process and discourse); Sfard & Kieran, 2001 (on interaction); Sfard, 2001 (on classroom interaction and discourse); Gee, 2005 (on discourse analysis); Garcia, 2009 (on classroom discussions); Genç, 2016 (on positive discourse); Çelik, 2019 (on mathematical discourse); Uğurel, 2010 (on classroom discourse); Abu Katılı, 2021 (on positive discourse); Çulhan, 2022 (on discourse analysis)] were also examined. In the literature review, no study on the positive discourse scale has been found. In this sense, it is thought that the contribution of this scale to the field is important. The aim of the study is to develop a valid and reliable scale for third and fourth grade primary school students to evaluate positive discourse in teaching.

Method

The research design used in the process of developing the "Positive Discourse Scale in Teaching" ("PDST"), the studies conducted during the scale development process, the study group and data analysis are presented below.

Research Design

The research is a descriptive study using a screening model that aims to develop a valid and reliable measurement tool for third and fourth grade primary school students' evaluation of positive discourse in teaching. Descriptive research, which is widely used in the screening model in the field of education, aims to describe a given situation as completely and carefully as possible (Büyüköztürk, et al., 2018). Factor analysis, which is used to examine the validity of a construct in scale development studies, is a statistical method that is widely used in social sciences (Seçer, 2015) and reveals whether the developed measurement tool reveals the theoretical framework appropriately (Büyükkıdık, 2020).

DeVellis (2003) states that eight steps should be followed in scale development. First of all, he states that it is necessary to determine what is intended to be measured. Secondly, the theoretical framework of the variable and related variables should be elaborated in detail. Next, an item pool should be created, and then the format of the measurement tool should be decided. The next step is the examination of the items by experts. Next, item validity should be ensured. Then, the items should be evaluated by applying the scale and the final version of the scale should be established (Şahin & Boztunç Öztürk, 2018).

Studies on Scale Development

Before starting the scale development study, a literature review was conducted. Studies on how to evaluate positive discourses in teaching were reviewed. In these studies, it was seen that discourses were mostly analyzed by discourse analysis. In addition, studies on teaching practices that will increase the quality of discourse in the educational process were reviewed (Tobias, 2009; Stein et al., 2007; Sfard, 2001; Garcia, 2009; Cirillo, 2013; Chapin et al., 2009; Ben-Yehuda et al., 2002). In the reviewed studies, information on how students' discourse can be more efficient and effective in the classroom environment was examined in detail. In particular, Chapin et al.'s (2009) five teaching methods for improving discourse quality were examined in detail. By looking at the classroom applications of these methods, an item pool was created for students to evaluate positive discourse. At the same time, an interview form was prepared by the researchers. Through the interview questions, interviews were conducted with primary school first, second, third and fourth grade students (two students from each grade level). In the interview the questions such as "How is your communication with your teacher?", "How does your teacher speak during lessons?", "What are your teacher's attitudes towards you, the way he/she speaks and communication processes?", and "Would you like to tell us?" were asked. The answers given by the students in the interviews were recorded with audio recordings and the recordings were listened to carefully by the researchers repeatedly on the computer. Moreover, teaching methods that can be used to increase the quality of positive discourse were examined from the literature and an item pool of 81 items was created. In the 81-item scale, negative items were added in addition to positive items. The four-point Likert scale (Strongly Disagree, Disagree, Agree, and Strongly Agree) was prepared and made ready for application for primary school students. Since it was stated that studies conducted with children between the ages of 8-16 emphasized that the most appropriate option for children is the four-point Likert type, as stated by Borgers et al., (2004), this scale was prepared in the four-point Likert type. At the same time, the four-point

Likert type "I am undecided" option in the five-point Likert type was preferred because individuals avoid expressing their thoughts (Yiğit and Kurnaz, 2010). In order to determine the extent to which this scale measures the expected behaviors (Balcı, 2005), the items were sent to experts for evaluation to ensure content validity. The items in the item pool were sent to three field experts to determine the extent to which the items covered the characteristic to be measured. In the feedback from the experts, it was stated that some of the items should be expressed more clearly considering that students, especially at the primary school level, may have difficulties in understanding abstract concepts. Based on the feedback from the experts, the following statements were rearranged:

"Instead of "My teacher listens", "My teacher is a good listener",

"Instead of "My teacher is dull in the lesson", "My teacher is not lively and active in the lesson, he is dull",

"Instead of "My teacher scares us, my teacher scares us by saying that this lesson is difficult".

After necessary corrections were made, the draft scale was applied to primary school students as a pre-test. Three students from each grade level were asked to read and answer the scale aloud in a suitable empty classroom. Here, it was determined whether there were any words and/or concepts that students had difficulty understanding. During the application of the scale with students from each grade level, they were asked to think and answer aloud. The feedback given by the students was noted in detail by the researchers. For the prepared scale, 30 minutes was determined as a pre-test application. The scale was answered one on one with each student. Since there were 81 items in the scale, it was found that the 1st and 2nd grade students got bored towards the end and did not understand the last items. In addition, as the time given was not enough for the 1st and 2nd grade students, it was determined that their attention was distracted. For this reason, it was concluded that the scale would be more suitable for third and fourth grade students.

Participants

The study group of the research consists of primary school students in Efeler district of Aydin province, in Türkiye. In order to develop the scale of positive discourse in teaching, non-random convenience sampling method was selected. In the non-random convenience sampling method, the process of inclusion in the study group continues until the participants at the most accessible level are reached in order to prevent loss of time, money and labor

(Büyüköztürk et al., 2018). With the convenience sampling method, 444 students studying in public primary schools were included in the study for exploratory factor analysis in scale development. The sample size in the study was determined by making sure that the sample size was at least five times the number of items, as stated by Bryman and Cramer (2001). Information about the students in the study is given in the table below.

Table 1 Students included in the study for exploratory factor analysis (study group I)

Characteristics		**n**	**%**
Gender	Male	215	48
	Female	229	52
Grade	Third Grade	220	49
	Fourth Grade	224	51

As shown in Table 1, 48% of the 444 primary school students were male and 52% were female. At the third grade level, 220 students (49%) and at the fourth grade level, 224 students (51%) participated in the study.

The second study group, which was determined for confirmatory factor analysis (the scale consisting of 25 items as a result of exploratory factor analysis), consisted of 317 students from public primary schools in the Efeler district of Aydın province with the appropriate sampling method. Information about these students is given in the table below.

Table 2 Students in the study for confirmatory factor analysis (study group II)

Characteristics		**n**	**%**
Gender	Male	150	47
	Female	167	53
Grade	Third Grade	155	48
	Fourth Grade	162	52

As shown in Table 2, 47% of the 317 primary school students were male and 53% were female. 155 students (48%) at the third grade level and 162 students (52%) at the fourth grade level participated in the study.

Data Analysis

For data analysis, validity and reliability analyses were conducted using SPSS 27.0 for exploratory factor analysis and Jamovi 2.2.5 and AMOS 24 for confirmatory factor analysis.

Exploratory factor analysis (EFA) and then confirmatory factor analysis (CFA) were conducted for construct validity. Cronbach's alpha value and McDonald's ω value were calculated to determine the reliability of the scale.

Findings and Discussions

Kaiser- Meyer-Olkin test (KMO) analysis was performed to evaluate whether the sample size was sufficient. As a result of this analysis, the KMO value was calculated as .948. This value was accepted as an indicator that the sample size was sufficient. In addition, Barlett's test of sphericity was analyzed to ensure that the distribution in the universe should be normal in factor analysis and the value obtained was found to be significant ($\chi 2$=4134.603; p=.00). The items of the 81-item scale were evaluated in terms of whether the overlap and factor loading values met the acceptance level. 20 items (1,3,4,7,9,9,10,11,14,20,23,24,25,26,28,29,42,45,48,75,79) with factor loadings below 0.30 and overlapping items (items with a difference of . 10 or less) 36 items (2,5,6,8,12,16,17,19,21,22,27,30,31,32,35,36,39,41,43,44,46,47,49,50,52,53,56,59,61,62,68,70,72,76,78,80) were removed from the scale respectively.

The factors and eigenvalues table formed as a result of the exploratory factor analysis are given below.

According to Table 3, when the eigenvalues were analyzed, it was concluded that there were 4 factors with a value greater than 1. It can also be seen from this table that the scale consisted of 4 factors as a result of exploratory factor analysis. In addition, the scree plot was also analyzed to determine the dimensions of the scale.

The scree plot resulting from the exploratory factor analysis is shown below.

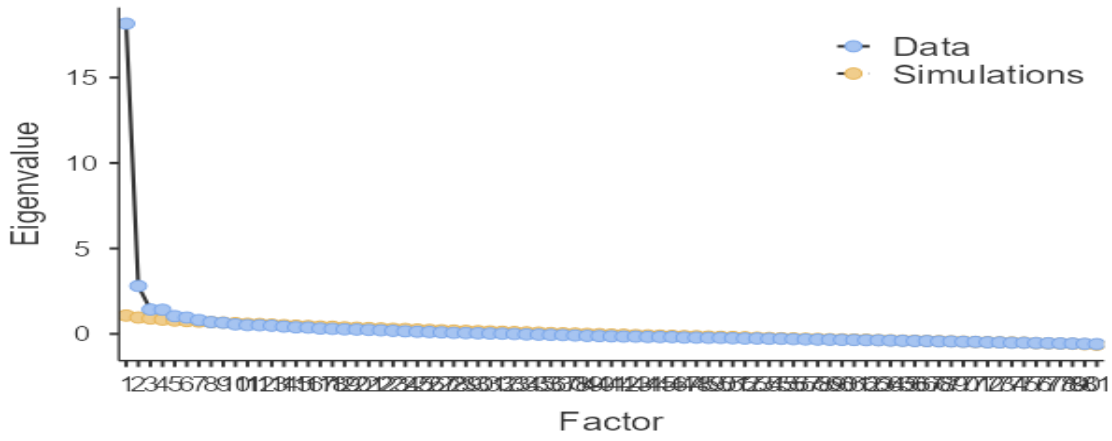

Figure 1 Scree plot as a result of exploratory factor analysis

As seen in Figure 1, for the data set generated by the Jamovi program and both simulated curves, it can be seen that a significant portion of the variance was explained by the first, second, third and fourth factors, and the eigenvalues of the factors following the fourth factor were much closer to each other. When the eigenvalues table and the slope accumulation graph were analyzed, it was confirmed that the scale had a four-factor structure.

As a result of the exploratory factor analysis, factor loadings were calculated before transformation. The factor loadings are presented in Table 4 below.

Table 4 Factor Loadings Before Transformation

Item Number	Factor 1	Factor 2	Factor 3	Factor 4
I 66	.703	-.126	.202	-.045
I 71	.689	-.063	.196	-.131
I 65	.675	-.090	-.161	.058
I 60	.667	-.141	-.328	-.028
I 51	.661	-.031	.077	.342
I 77	.660	-.174	.127	-.039
I 67	.657	-.351	.127	-.132
I 58	.656	-.169	-.264	-.064
I 63	.638	.012	-.312	.044
I 74	.632	-.246	.067	-.218
I 69	.623	-.045	-.160	-.203
I 34	.615	.251	-.168	-.102
I 73	.607	-.117	.320	-.276
I 38	.595	.363	-.116	-.045
I 57	.595	-.004	-.376	.323
I 54	.593	-.089	-.275	.064
I 15	.576	.124	.015	.462
I 81	.570	-.211	.306	.143
I 40	.557	.442	.036	.064
I 55	.551	-.247	-.282	-.184
I 37	.525	.489	.261	-.231
I 13	.513	.011	.201	.414
I 64	.506	-.035	.217	.067
I 18	.499	.350	.182	.046
I 33	.497	.432	-.161	-.276

Principal Factors Analysis was used as a factorization method to reveal the factor pattern in the PDST, and it was decided to use the Varimax method, one of the orthogonal rotation methods commonly used in social sciences, as a rotation method (Çokluk et al., 2018). The factor loadings after rotation are given in the table below.

Table 5 Factor Loadings After Rotation

Item Number	Factor 1	Factor 2	Factor 3	Factor 4
I 73	.686			
I 67	.664			
I 66	.600			
I 74	.596			
I 71	.588			
I 81	.558			
I 77	.552			
I 65	.509			
I 64	.414			
I 60		.664		
I 58		.616		
I 57		.604		
I 55		.600		
I 63		.593		
I 54		.562		
I 69		.495		
I 37			.730	
I 33			.653	
I 40			.605	
I 38			.575	
I 18			.516	
I 34			.501	
I 15				.658
I 13				.614
I 51				.585

When examining Table 5, a 25-item structure consisting of 4 factors was observed. When the factor loadings of these 25 items were examined, it can be seen that the values were at a sufficient level. Barnes et al., (2001) also stated that the size of the factor loadings should be at least 0.30 within the scope of EFA. As a result of the EFA analysis, 9 items (73,67,66,74,71,81,81,77,65,64. items) of the 4-factor 25-item scale were grouped under factor 1, 7 items (60,58,57,55,63,54,69. items) under factor 2, 6 items (37,33,40,38,18,34. items) under factor 3 and 3 items (15,13,51. items) under factor 4.The variance values of the scale consisting of 25 items with four factors are given in the table below.

Table 6 Eigenvalues Statistical Values of the Four-Factor Structure

	Factor Rotation Eigenvalues		
Factor	Total	Variance Explained (%)	Cumulative Variance Explained (%)
1	3.934	15.737	15.737
2	3.611	14.444	30.181
3	2.856	11.426	41.607
4	2.372	9.489	51.096

As seen in Table 6, the individual contribution of each factor to the total variance was found to be 15.737% for factor 1, 14.444% for factor 2, 11.426% for factor 3 and 9.489% for factor 4. The total contribution of the four-factor structure to the variance is 51.096%. As stated by Özdamar (2016), in scale development studies in the field of education and social sciences, it is accepted that the total variance ratio is acceptable between 40% and 60%.

Nomenclature of Factors

In this study, after the EFA, the items collected under the factors were examined and the factors of the Positive Discourse Scale in Teaching were named as shown in the table below.

Table 7 Factor Nomenclature of the Positive Discourse Scale in Teaching

Positive Discourse Scale In Teaching (PDST)	Managing Positive Discourse	I 73	Is consistent in what he/she says and what he/she does.
		I 67	Supports our creative ideas.
		I 66	Respects the diversity of our ideas.
		I 74	Is sensitive, sensitive to our personal problems.
		I 71	Cares about our optimistic approach to the problems we face.
		I 81	Is attentive, notices changes in our attitude or behavior.
		I 77	Gives us the opportunity to correct our mistakes.
		I 65	Allows us to express our ideas freely.
		I 64	Thinks it is normal for us to make mistakes.
	Encouraging Positive Discourse	I 60	Expresses that we are talented.
		I 58	Boosts our confidence to succeed in the lesson.
		I 57	Believes that we will do our best in the tasks he/she gives us.
		I 55	Gives us the opportunity to speak when we want to have a say.
		I 63	Encourages us for the given tasks.
		I 54	Values respect for each other in discussions.
		I 69	Values kindness towards each other.
	Environment and Components Supporting Positive Discourse	I 37	Drives us to inquire.
		I 33	Asks questions that lead us to be able to work together.
		I 40	Increases our ability to solve our problems and issues.
		I 38	Teaches the lesson in a fun way without boring us.
		I 18	Gives explanatory answers to our questions.
		I 34	The arrangement of the classroom is suitable for collaboration.
	Sustaining/ Supporting Positive Discourse	I 15	Appreciates our efforts.
		I 13	Is sincere and genuine with us.
		I 51	Helps us when we need help.

Managing Positive Discourse, Encouraging Positive Discourse, Environment and Components Supporting Positive Discourse, and Sustaining/Supporting Positive Discourse were determined as factor names in the Positive Discourse Scale in Teaching.

Confirmatory Factor Analysis

Confirmatory factor analysis was conducted on the EFA data obtained based on the data of 317 primary school third and fourth grade level participants. Numerical information about

the estimation, standard error and z values resulting from the confirmatory factor analysis are given in the table below.

Table 8 Confirmatory factor analysis estimation, standard error and z values

Factor	Item	Estimated Value	Standard Error	Z Value	p
Factor 1	I 73	0.497	0.0457	10.89	< .001
	I 67	0.516	0.0511	10.10	< .001
	I 66	0.516	0.0430	11.98	< .001
	I 74	0.508	0.0494	10.29	< .001
	I 71	0.557	0.0428	13.01	< .001
	I 81	0.425	0.0463	9.18	< .001
	I 77	0.429	0.0424	10.13	< .001
	I 65	0.574	0.0445	12.88	< .001
	I 64	0.471	0.0506	9.30	< .001
Factor 2	I 60	0.538	0.0550	9.78	< .001
	I 58	0.393	0.0514	7.65	< .001
	I 57	0.485	0.0511	9.50	< .001
	I 55	0.504	0.0509	9.89	< .001
	I 63	0.474	0.0449	10.56	< .001
	I 54	0.464	0.0456	10.18	< .001
	I 69	0.552	0.0478	11.54	< .001
Factor 3	I 37	0.520	0.0514	10.12	< .001
	I 33	0.501	0.0512	9.79	< .001
	I 40	0.569	0.0457	12.46	< .001
	I 38	0.506	0.0495	10.22	< .001
	I 18	0.489	0.0460	10.64	< .001
	I 34	0.563	0.0472	11.93	< .001
Factor 4	I 15	0.481	0.0500	9.62	< .001
	I 13	0.489	0.0529	9.23	< .001
	I 51	0.429	0.0402	10.66	< .001

When the data in Table 8 was examined, it can be seen that the unstandardized estimation values were generally around 0.5 and the z values were statistically significant. This significance showed that the items were related to the factors.

Model fit indices for confirmatory factor analysis are presented in the table below.

Table 9 Model Fit Index Values

χ 2/sd	RMSEA	SRMR	TLI	CFI	GFI	AGFI
1.87	0.05	0.05	0.88	0.90	0.90	0.87

Looking at the fit indices in Table 9, it was concluded that the relative chi-square value (χ 2/sd) was 1.87. The fact that this value was less than 5 indicated an acceptable fit according to Çelik and Yılmaz (2013) and Aksu et al., (2017). The SRMR value in the table was 0.05. Maydeu-Olivares et al., (2017) stated that a value less than 0.08 indicates a good fit. The TLI value was found to be 0.88. Bentler and Bonett (1980) suggested that this value between 0.85 and 0.9 is also a good fit. In addition, Bentler (1980) stated that a CFI value between 0.8 and 0.9 indicates an acceptable fit. As a result of the analysis, CFI was found to be 0.9, which was acceptable. Considering GFI, a value equal to or greater than 0.9 is stated to be a good fit according to Tanaka and Huba (1985). Meanwhile, a AGFI value of 0.86 and a RMSEA value of 0.05 indicate also an acceptable fit. According to the table values and criterion values, it can be seen that model-data fit was achieved.

The path diagram including the standard path coefficients for the validated model is shown in Figure 2.

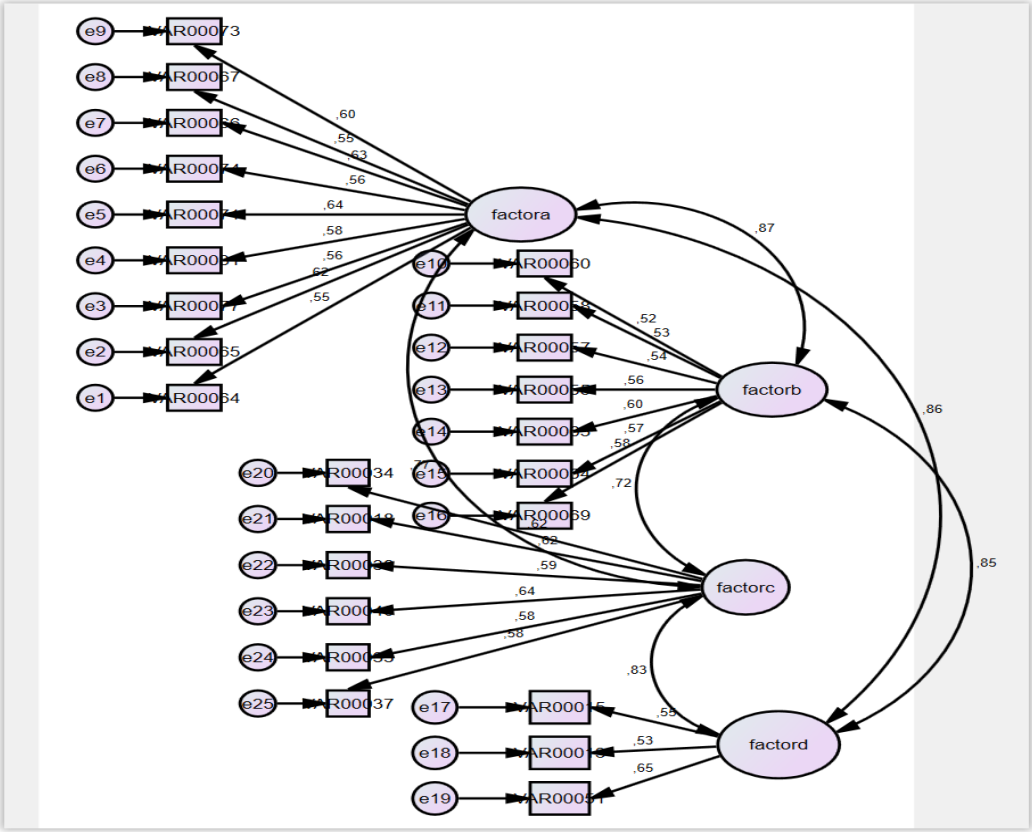

Figure 2 Path Diagram of the PDST

When the visualization of the factor structures in Figure 2 was examined, the factor loadings of the items in the scale for four different sub-dimensions were greater than 0.50. These factor values were found to be statistically significant according to t values within the scope of parametric testing. It was also concluded that the criterion of Şimşek (2007) that factor loadings should be greater than 0.5 without considering the statistical test condition was met.

The 25-item Pearson Product Moment correlation analysis of the scores obtained from the sub-factors of the PDST is presented in the table below.

Table 10 Pearson Product Moment Correlation Values of the PDST and Subfactors

	Factor 1		Factor 2		Factor 3		Factor 4		Scale
Factor 1	1								
Factor 2	0.87	***	1						
Factor 3	0.62	***	0.72	***	1				
Factor 4	0.86	***	0.85	***	0.83	***	1		
Scale	0.90	***	0.85	***	0.81	***	0.74	***	1

* p < .05, ** p < .01, *** p < .001

Correlation analysis was conducted to determine the relationship between the Positive Discourse Scale in Teaching and the factors that make up the scale, and it was seen that there was a significant and highly positive relationship between the total score of the scale and the factors that make up the scale. When the correlation values between the factors were analyzed, it can be seen that each factor had a moderate relationship with the other factor. According to Büyüköztürk (2018), a correlation value between 0.70-1.00 is defined as a high level relationship, 0.69-0.30 as a moderate level relationship, and 0.29-0.00 as a low level relationship.

The reliability values resulting from the application of the Positive Discourse Scale in Teaching are given below.

Table 10 Reliability Values

	Cronbach's α	McDonald's ω
Managing Positive Discourse (Factor 1)	0.824	0.826
Encouraging Positive Discourse (Factor 2)	0.758	0.759
Environment and Components that Support Positive Discourse (Factor 3)	0.774	0.776
Sustaining/ Supporting Positive Discourse (Factor 4)	0.610	0.614
Positive Discourse Scale in Teaching	0.909	0.911

When the reliability values in the table were analyzed, the Cronbach's Alpha value of the sub-dimension of managing positive discourse was 0.82 and McDonald's Omega coefficient was 0.82. The Cronbach's Alpha value of the encouraging positive discourse sub-dimension was 0.76, and McDonald's Omega coefficient was 0.76. The Cronbach Alpha value of the environment and components supporting positive discourse sub-dimension was 0.77 and McDonald's Omega coefficient was 0.78. The Cronbach Alpha value of the sub-dimension of sustaining/supporting positive discourse was 0.61 and McDonald's Omega coefficient was 0.61. For the whole scale, Cronbach's Alpha value was 0.91 and McDonald's Omega coefficient was 0.91. According to Fraenkel et al. (2012), a reliability coefficient of 0.70 and above is considered to be at a good level in social sciences. Accordingly, it can be seen that the reliability of the developed scale is at a good level. It was concluded that only the value of the sub-dimension of sustaining/supporting positive discourse was below 0.70, at the level of 0.60. In this sense, Nunnally (1978) stated that the reliability coefficient in social sciences can be at the level of .60 in scale development studies (as cited in Özbaşı et al., 2018).

Conclusions and Suggestions

In this study, it was aimed to develop a valid and reliable measurement tool to be used within the scope of primary school third and fourth grade students' evaluation of positive discourse in educational processes. In the study, first of all, the items created within the framework of the theoretical structure related to discourse and positive discourse were made ready to students and applied to primary school students after expert evaluations and a pilot application. Exploratory factor analysis was performed to determine the construct validity of the scale in the data obtained. As a result of the analysis, it was concluded that the Positive Discourse Scale in Teaching, which consists of four sub-dimensions, was composed of 25 items and explained 51% of the total variance. After the exploratory factor analysis, confirmatory factor analysis was performed, and the fit indices were examined without removing any items. The fit indices (Chi-square/freedom value: 1.87; RMSEA: 0.05; SRMR: 0.05; TLI: 0.88; CFI: 0.90; GFI: 0.90 and AGFI: 0.86) were found to be within acceptable limits and the four sub-dimensional structure of the scale, namely managing positive discourse, encouraging positive discourse, environment and elements supporting positive discourse and sustaining/supporting positive discourse, was confirmed. In addition, Cronbach's alpha and McDonald's Omega reliability values of the Positive Discourse Scale in Teaching and its sub-dimensions were calculated. The Cronbach Alpha value of the sub-

dimension of managing positive discourse was found 0.82, and McDonald's Omega coefficient was found 0.82. The Cronbach's Alpha value of the encouraging positive discourse sub-dimension was found 0.76, and McDonald's Omega coefficient was found 0.76. The Cronbach Alpha value of the environment and components supporting positive discourse sub-dimension was found 0.77 and McDonald's Omega coefficient was found 0.78. The Cronbach's Alpha value of the sub-dimension of sustaining/supporting positive discourse was 0.61 and McDonald's Omega coefficient was 0.61. For the whole scale, Cronbach's Alpha value was 0.91 and McDonald's Omega coefficient was 0.91. In line with these results, it can be seen that the scale was reliable. When the national and international literature is examined, there is no scale through which positive discourse was evaluated by elementary school students. In this sense, it can be said that this scale will contribute to the gap in the field.

The scale consists of 25 items and is a four-point Likert scale. Since there are no negative items in the score calculation of the scale, a maximum of 100 points and a minimum of 25 points can be obtained. This scale is important for revealing the positive discourse of teachers in primary schools. Considering the duration of students' primary school education, determining the level of discourse of teachers will help teachers plan a more effective teaching process. Of course, this scale was developed to be evaluated by students, but considering the teaching process, a scale can also be developed to determine the positive discourse levels of students. In this way, more effective positive classroom discourses and environments can be created based on the discourse evaluations of teachers and students. In addition, this scale, which was designed for students to evaluate the discourses in different subjects, will help to reveal the discourses of teachers of different subjects. For this reason, the scale can also be evaluated to determine the differences in the discourses in each lesson. During the teaching process, teachers help students structure knowledge. In addition, teachers need to help students understand the information given in lessons and encourage students' discourse. It can be thought that this developed scale will help teachers make the discourses they use in the teaching process more positive and encouraging.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

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Research involving Human Participants and/or Animals

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Öğretimde Olumlu Söylem Ölçeği: Geçerlik ve Güvenirlik Çalışması

Özet:

Bu çalışmada öğretim süreçlerinde ilkokul üçüncü ve dördüncü sınıf öğrencilerinin olumlu söylemleri değerlendirebilmeleri için kullanılacak geçerli ve güvenilir bir ölçme aracı geliştirmek amaçlanmıştır. Çalışma için alanyazında söylem ve olumlu söylem ile ilgili çalışmalara taranarak madde havuzu oluşturulmuştur. Hazırlanan maddeler uzman değerlendirmeleri ve öğrencilere ön uygulamadan sonra hazır hale getirilmiştir. Ölçek uygulaması yapıldıktan sonra geçerlik kapsamında açımlayıcı faktör analizi yapılmış ve toplam varyansın % 51'inin açıklandığı 25 maddeden oluşan dört alt boyuta sahip olduğu sonucuna ulaşılmıştır. Daha sonra doğrulayıcı faktör analizi yapılarak ki-kare değerinin (χ 2/sd) 1.87 olduğu, SRMR değerinin 0.05; TLI değerinin 0.88; CFI değerinin 0.9 olduğu sonucuna ulaşılmıştır. Ölçeğin bu yapıda uyumlu olduğu görülmüştür. Aynı zamanda ölçeğin güvenirlik hesaplamalarında Cronbach Alpha değeri ve McDonald'ın Omega katsayısı hesaplanmıştır. Öğretimde Olumlu Söylem Ölçeğinin tümü için Cronbach Alpha değeri 0.91, McDonald'ın Omega katsayısı 0.91 olduğu sonucuna ulaşılmıştır. Ölçeğin ilkokul üçüncü ve dördüncü sınıf öğrencileri için geçerli ve güvenilir bir ölçme aracı olduğu görülmektedir. Geliştirilen bu ölçek ilkokul öğrencileri tarafından olumlu söylemi değerlendirilmek amacıyla geliştirilmiştir. Öğretim süreci düşünüldüğünde öğretmenin, öğrencilerin olumlu söylem düzeylerini belirlemek amacıyla da bir ölçek geliştirilebilir.

Anahtar kelimeler: Olumlu söylem, Ölçek geliştirme, İlkokul üçüncü ve dördüncü sınıf öğrencileri.

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Research Article

Higher Education Instructors with Special Needs Students: Challenges and Recommendations

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Abstract – This research identifies the challenges encountered by higher education instructors who provide education to special needs students in their classes and the solutions they propose to address these challenges. The study investigated the level of knowledge of instructors regarding their students with special needs, the opinions of the instructors on encountered problems, the reasons and solutions of these problems, and the self-assessment of instructors and their institutions regarding the education provided to students with special needs. The participants of the study consisted of 25 higher education instructors who provide education to students with special needs in their classes. The participants were selected using maximum diversity and criterion sampling types of purposive sampling method. Data for the research were collected with semi-structured interview form and were analyzed using the descriptive content analysis method. Research findings showed that the instructors lacked sufficient knowledge about disabilities, did not feel qualified in terms of academic adaptations, found their higher education institution to be insufficient in terms of accessibility, and noted low awareness among academic and administrative staff. Research concluded that awareness-raising activities, personnel training regarding the characteristics of disabled students and possible accommodations, and necessary adjustments should be made in terms of accessibility. Recommendations were developed accordingly in this context.

Key words: academic adaptations, higher education instructors, students with special needs in higher education

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Introduction

In Turkey, the higher education system was restructured under Law No. 2547 in 1981, which brought all higher education institutions under a single umbrella organization known as the Higher Education Council (Yükseköğretim Kurulu), making it the sole authority responsible for higher education in the country. Since 1982, the number of universities has increased from 27 to 208 as of the present day (Higher Education Council, 2023). Nationwide, there are a total of 8,296,959 students enrolled in higher education institutions, and among these students, 55,667 are classified as students with special needs (Higher Education Information Management System, 2022). According to Article 130 of the Turkish Republic Constitution, which encompasses higher education institutions, these students have the right to education based on contemporary principles of education and training, aiming to develop human resources in accordance with the needs of the nation and the country, and taking measures to ensure equal opportunities in higher education. Therefore, students with special needs have the same right to benefit from educational opportunities as their typically developing peers. In higher education programs, the rights and services of individuals with special needs are governed by the Higher Education Institutions Disabled Students Advisory and Coordination Regulation (YÖKEDKY) in Turkey. This regulation aims to facilitate the academic life of students with special needs, create the necessary academic environment, and ensure their full participation in the education and training processes by taking the necessary measures and making arrangements (YÖKEDKY, 2010).

According to the Regulation on the Advisory and Coordination Unit of Students With Disabilities a student with special needs is defined as "a higher education student who, due to various degrees of loss of physical, mental, emotional, and social abilities, either congenital or acquired at a later stage, faces difficulties in adapting to social life, meeting daily needs, and requires protection, care, rehabilitation, counseling, and support services" (YÖKEDKY, 2010). The education of students with special needs encompasses various areas, including daily life skills, social skills, academic skills, and personal hygiene skills. The prerequisite skills that need to be developed for individuals with special needs can vary depending on the type and severity of their disabilities, and the required education for each individual may differ (Hughes et al., 2016; Grigorenko et al., 2020; Hall et al., 2003; Spooner et al., 2011; Diken et al., 2021). In higher education, students with special needs receive their education based on the programs they are enrolled in, and this education is provided by the instructors' members working at the university.

In order to create the most suitable learning environment for individuals with special needs in higher education, it is of great importance that both academic and administrative staff members are knowledgeable about students with special needs (Love et al., 2015; Madaus and Newman, 2015; Rose et al., 2006). Furthermore, to ensure that individuals with special needs do not face any difficulties during their higher education and to facilitate their lives, necessary legal regulations have been established, and regulations have been put in place (OEHY, 2018). However, studies that have gathered the opinions of students with special needs in higher education and the instructors' members who provide them with education indicate that these staff members may lack adequate knowledge about the types of disabilities and how to deliver educational content to students with special needs (Gibbons et al., 2015; Muhamad Zaki and Ismail, 2021; Zhang et al., 2018).

In order to ensure equal educational rights for students with special needs in higher education and to facilitate their learning, various instructional adaptations need to be implemented. Academic adaptations involve making educational, environmental, and communicational adjustments based on the student's specific needs. These adaptations aim to prevent any challenges that may arise for both students with special needs and the instructor's providing education, ultimately benefiting both parties (Harrison et al., 2013; Lovett and Nelson, 2021; Yang and Ma, 2022). Academic adaptations encompass a range of modifications that address the physical and educational aspects of the learning environment. These adjustments apply to educators across all levels and disciplines, ensuring they can deliver inclusive education (Bohning, 2000; Williams, 2001). Academic adaptations typically involve alterations in the classroom setup, teaching materials, instructional methods, and interactions between instructors and students tailored to the specific type of disability. Moreover, adaptations can extend to assessment methods and assignments. The implementation of academic adaptations not only enhances the teaching performance of educators but also empowers students with special needs to achieve success comparable to their typically developing peers, without encountering significant obstacles (Accardo et al., 2019; Bourke et al., 2000; Costello-Harris, 2019).

Examining the academic adaptations provided to students with special needs in the instructional content, it is evident from the international literature that there are studies investigating the challenges faced by instructors' members who provide education to students with special needs in higher education. These studies indicate that instructors' members may lack sufficient knowledge about the academic adaptations required for students with special

needs and the characteristics of these students. Consequently, they encounter difficulties in implementing the necessary adaptations (Chan, 2016; Gaad and Almotairi, 2013; Holmqvist et al., 2019; Jones and Krumsvik, 2008; Morina, 2017; Muhamad Zaki and Ismail, 2021). Besides, to address these issues, there is evidence of the establishment of inclusive education programs and support units for students with special needs in higher education aimed at creating appropriate conditions for them (Hall et al., 2003; Harrison et al., 2013; Hong and Himmel, 2009; Klenotich, 2022; Kurth and Keegan, 2014; Newman and Madaus, 2015; Morina et al., 2017). Reviewing the literature in Turkey, it is observed that studies involving university instructors predominantly focus on a single type of disability, such as visual impairment, hearing impairment, or physical disability. These studies typically investigate the challenges faced by students with a specific type of disability in higher education institutions and the proposed solutions to these challenges (Gündoğar, 2020; Karakuş et al., 2017; Özsökmen, 2019). In his study, Özsökmen (2019) described the opinions of conservatory educators who have visually impaired students regarding the educational process. The sample of the study consisted of conservatory students with visual impairments and faculty members who have students with visual impairments. In the study, the attitudes and approaches of faculty members who have visually impaired students were determined, deficiencies in the education process were identified and solutions to these situations were offered. This research focused on a single type of disability, visual impairment. In his study, Gündoğar (2020) examined the opinions about academic adaptations made for visually impaired students attending higher education. The sample of this study consists of visually impaired students attending higher education and faculty members who have visually impaired students. Similar to the previous study, the current study focused on visual impairment, but students studying at the university instead of the conservatory and faculty members working at the university were selected as samples. In addition, as a result of the study, future suggestions were made by accessing the findings regarding the higher education life of students with visual impairments. Karakuş et al. (2017) examined the educational problems faced by students with special needs in the field of education at Selçuk University. The data was obtained from interviews with students, students' parents and faculty members, and from applications made by students, students' parents and faculty members to the Disabled Student Unit. According to the findings, it was seen that the group that had the most problems in applications was the faculty members and they generally had problems in adapting lectures and exams. In addition, suggestions have been made regarding the educational adaptations of students with visual impairment, hearing impairment and physical disability, but no recommendations have been

made regarding other types of disabilities. Consequently, within the Turkish literature, there is a lack of comprehensive studies addressing the challenges encountered by instructors targeting all types of disabilities. In this context, the objective of this research is to identify the issues faced by instructors who teach students with various types of disabilities in higher education and the solutions they propose for these problems. In pursuit of this goal, the following research questions were addressed:

1. What is the knowledge of instructors who have students with special needs in higher education institutions regarding these students?
2. What are the challenges faced by instructors who have students with special needs in higher education institutions?
3. What are the reasons behind the challenges faced by instructors who have students with special needs in higher education institutions?
4. How do instructors in higher education evaluate themselves and their institutions regarding the education provided to students with special needs?
5. What are the solution proposals offered by instructors who have students with special needs in higher education institutions to address the challenges they encounter?

Method

Research Design

In this study, a descriptive phenomenological design, which is one of the qualitative research methods, was employed. The research aimed to deeply investigate the problems faced by instructors working in higher education institutions who have students with special needs, the reasons behind these problems, and the solutions proposed to address these issues. Phenomenological design is a research approach that involves an in-depth and detailed examination of phenomena (events, experiences, perceptions, orientations, concepts, etc.) Conducting research where phenomena are recognized, however, our knowledge about them is lacking in depth and detail, a phenomenological design can provide a foundation for the study. The descriptive phenomenological design is formed by describing phenomena in a detailed manner (Silverman, 2011; Patton, 2014; Creswell and Creswell, 2018).

Participants

In this study, purposive sampling methods, specifically maximum diversity and criterion sampling types, were employed as qualitative research sampling methods. Purposive sampling involves the deliberate selection of a sample believed to adequately represent a specific population. The maximum diversity approach within purposive sampling aims to construct a concise sample while maximizing the diversity of individuals who can significantly contribute to the issue under investigation (Cohen et al., 2018; Mills and Gay, 2012; Yıldırım and Şimşek, 2021). The criterion sampling type within purposive sampling involves selecting cases that meet predetermined criteria. In determining the research sample, contact was established with the Disability Student Units of universities to access various faculties and departments in higher education institutions, following the maximum diversity type. Additionally, for the criterion sampling type, the criteria were set as follows: (a) currently serving as instructors at higher education institutions in Izmir province and (b) having students with special needs enrolled in their courses. Consequently, the research participants consist of a total of 25 individuals who are instructors serving in state universities, private universities, state vocational schools, and private vocational schools in Izmir province. Participant P01 was not included in the data analysis of the study and to Table 1. below because he was a research assistant and did not meet the criteria of a lecturer, and P08 was not included in the data analysis of the study and the Table 1. below because his student did not meet the criterion of a student with special needs. Information about participants and students with special needs is presented in Table 1.

Table 1 Information about Participants and Students with Special Needs

Code	Gender	Age	Title	Faculty/Higher Education Institution	Type(s) of Disability of The Students
P02	Female	38	Lecturer	School of Foreign Languages	Asperger
P03	Female	30	Lecturer	Child Development and Youth Services	Hearing Impairment/ Intellectual Disability
P04	Female	29	Lecturer	Child Development and Youth Services	Hearing Impairment/ Learning Disability/ Intellectual Disability
P05	Female	34	Research Professor, Ph.D.	Faculty of Education	Visual Impairment
P06	Male	30	Research Professor, Ph.D.	Faculty of Education	Speech and Language Impairment/ Physical Disability/ Visual Impairment
P07	Male	40	Research Professor, Ph.D.	Faculty of Fine Arts	Down Syndrome/ Autism Spectrum Disorder/ Dyslexia
P09	Female	48	Professor, Ph.D.	Faculty of Communication	Speech and Language Impairment/ Physical Disability/ Attention Deficit and Hyperactivity Disorder/ Autism Spectrum

					Disorder/ Learning Disability/ Intellectual Disability
P10	Female	42	Research Professor, Ph.D.	Faculty of Communication	Speech and Language Impairment/ Physical Disability /Visual Impairment
P11	Male	40	Research Professor, Ph.D.	Faculty of Communication	Physical Disability/ Dyslexia
P13	Female	36	Associate Ph.D.	Faculty of Education	Physical Disability/ Visual Impairment
P14	Female	48	Associate Professor	Faculty of Education	Speech and Language Impairment/ Physical Disability
P15	Male	48	Professor	Faculty of Science	Physical Disability/ Attention Deficit and Hyperactivity Disorder/ Head Injury*
P16	Male	41	Research Professor, Ph.D.	Faculty of Science	Speech and Language Impairment/ Physical Disability/ Attention Deficit and Hyperactivity Disorder
P17	Female	42	Associate Ph.D.	Faculty of Science	Hearing Impairment
P18	Female	39	Research Professor, Ph.D.	Faculty of Education	Hearing Impairment
P19	Female	39	Research Assistant	Faculty of Education	Physical Disability/ Visual Impairment
P20	Male	40	Associate Ph.D.	Faculty of Education	Speech and Language Impairment/ Hearing Impairment
P21	Female	34	Lecturer	Child Development and Youth Services	Speech and Language Impairment/ Physical Disability/ Visual Impairment/ Attention Deficit and Hyperactivity Disorder/ Hearing Impairment/ Intellectual Disability
P22	Female	26	Lecturer	Faculty of Fine Arts	Down Syndrome/ Autism Spectrum Disorder
P23	Female	38	Research Professor	Faculty of Literature	Speech and Language Impairment/ Physical Disability/ Visual Impairment/ Autism Spectrum Disorder/ Asperger
P24	Female	42	Research Professor	Faculty of Education	Physical Disability/ Visual Impairment/ Hearing Impairment/ Autism Spectrum Disorder
P25	Male	42	Research Professor, Ph.D.	Faculty of Engineering	Hearing Impairment/ Autism Spectrum Disorder/ Dyslexia
P26	Female	34	Lecturer	School of Foreign Languages	Visual Impairment
P27	Female	28	Lecturer	School of Foreign Languages	Visual Impairment
P28	Female	43	Professor	Faculty of Economics and Administrative Sciences	Physical Disability

Upon reviewing Table 1, it is observed that the types of disabilities among the students with special needs include physical disability, visual impairment, hearing impairment, language and speech disorders, Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, intellectual disability, Down Syndrome, and Specific Learning Difficulties. To ensure the anonymity of the participants, the instructors have been assigned code names ranging from "P02, P03..., to P28". Upon examining the faculty/higher education institutions

where instructors are currently employed , it is observed that the participants are currently employed across eight different faculties or higher education institutions. To preserve anonymity, this table is provided separately.

Data collection

The study data were collected using a semi-structured interview form. The semi-structured interview form was developed by drawing on theses and articles in the field of special education (Gündoğar, 2020; Özsökmen, 2019; Zeybek, 2015). After its development, the form was submitted for review to three experts who hold doctoral degrees in the field of Special Education. Necessary modifications were made based on the experts' feedback, and the semi-structured interview form was finalized. The final version of the semi-structured interview questions used in the research consists of a total of nine questions.

A pilot interview was conducted with a faculty member who met the sample criteria to evaluate the questions in the interview form. Subsequently, interviews were conducted face-to-face and online in quiet environments with participants who volunteered and expressed their willingness, between the dates of July 17, 2022, and October 13, 2023. Before the interviews began, a detailed consent form outlining the research objectives and process, along with a demographic information form, was provided to the participants. Interviews were recorded with the consent of the participants. The interview form is designed with nine open-ended questions that aim to explore the challenges faced and solutions suggested by instructors who have students with special needs. The duration of the interviews ranged from 12 to 45 minutes. The recorded data was transcribed by the researcher and transferred to a digital format and analyzed using content analysis.

Data Analysis

The collected data were analyzed using inductive content analysis, one of the qualitative data analysis methods. Inductive content analysis is the process of uncovering the concepts within the data to reach unknown phenomena and develop theory (Miles et al., 2014). Concepts form the codes, and relationships form the themes. In inductive coding, codes are directly obtained from the research data. After transcribing the recorded interviews, the researcher participated in the coding process, noting thoughts and impressions related to the content. The researcher formed codes based on similar expressions and patterns and established themes based on the relationships and distinctive differences among codes. To ensure coding reliability, the necessary data for coding reliability were sent to two faculty members in the field of Special

Education who were experienced on qualitative research field. In line with the literature, necessary adjustments have been made on the codes and themes, and a consensus has been reached to finalize them. Within the scope of content analysis, important opinions of the participants have been provided as direct quotes under the relevant themes. According to the reliability formula proposed by Miles and Huberman (1994), the inter-coder agreement rate has been determined as 91.17%. An agreement rate of 70% and above is considered as a sufficient reliability value. The themes and sub-themes obtained as a result of the data analysis are presented in Table 2.

Table 2 Themes and Sub-Themes Related to the Views of Instructors

	Theme		Sub-Theme
1.	Knowledge of instructors about individuals and students with special needs	1.1.	Knowledge status of instructors about individuals with special needs
		1.2.	Instructors' awareness of their students with special needs
2.	Instructors' competencies in teaching students with special needs	2.1.	The knowledge/education of instructors about teaching students with special needs
		2.2.	Adaptations made by instructors for their students with special needs
		2.3.	Instructor's views about the education they provided to students with special needs
3.	The views of the instructors on the services for individuals with special needs provided by the higher education institution they work in		
4.	Challenges faced by instructors in the higher education institution where they work		
5.	Reasons for the challenges encountered by instructors		
6.	Suggestions by instructors for better education for students with special needs		

Validity and Reliability

While validity and reliability are expressed with numerical data in quantitative research, qualitative research does not employ numerical data for these purposes. Therefore, the validity and reliability of studies in qualitative research are ensured through trustworthiness. Criteria for trustworthiness are grouped under four headings: credibility, dependability, confirmability, and transferability (Guba and Lincoln, 1982). The trustworthiness of research findings is established through various factors, such as the researcher taking necessary precautions, clearly and thoroughly describing the research process and data and selecting a sample size that is sufficiently large (Başkale, 2016).

Credibility

For a study to be scientifically accepted, both the research process and its findings need to be transparent. Various strategies exist to ensure credibility. In this research, credibility has been established through expert review. During the expert review, the expert monitors the entire process from data collection to its analysis and the writing of the results, providing critical feedback to the researcher. This strategy can be implemented in two ways: either through a review meeting between the expert and the researcher or by sending all the data to the expert for feedback (Yıldırım and Şimşek, 2021). In the present study, the former strategy was employed by the study's researchers.

Transferability

The concept of generalizability in quantitative research is referred to as transferability in qualitative research. Detailed descriptions or purposeful sampling methods are used to increase the transferability of study results (Yıldırım and Şimşek, 2021) In this study, purposeful sampling was used to ensure transferability.

Findings

The findings obtained at the end of the research are grouped under six themes: the knowledge level of instructors about individuals and students with special needs, the competence of instructors in teaching students with special needs, the quality of services provided to individuals with special needs by the higher education institution where instructors work, the problems faced by instructors in their higher education institution, the reasons for the problems encountered by instructors, and the suggestions of instructors for better education for students with special needs. Codes related to the themes and direct quotations have been presented in sequence.

Knowledge of Instructors About Individuals and Students with Special Needs

Themes and codes related to the knowledge of instructors who have students with special needs in their classes are presented in Table 3.

Table 3. Knowledge Status of Instructors About Individuals with Special Needs

Codes	*f*
I have knowledge about the types of disabilities	13
I have knowledge about the problems and needs they experience	10
I don't have comprehensive knowledge about students with special needs	7
I have knowledge about the education and training of individuals with special needs	6
I have knowledge about legal studies related to individuals with special needs	2

Upon examining Table 3., it has been determined that the majority of participants possess knowledge regarding the types of disabilities related to individuals with special needs and the challenges and necessities these individuals face. Among other topics that participants are knowledgeable about include the education and teaching of individuals with special needs and legal initiatives undertaken for these individuals. Seven participants have expressed that they do not possess comprehensive knowledge about students with special needs. Some statements from the participants is as follows:

"Individuals with learning difficulties, visual impairments, physical disabilities, those who cannot use their limbs, such as Asperger syndrome." (P26)

“It's not just one disability group, it's not just one inadequacy group. I know they are all grouped under a large umbrella. Even if they have received the same diagnosis under this umbrella, I am aware that there are still individual differences." (P03)

"I have some knowledge that they have different characteristics, and based on these characteristics, they may experience some difficulties in performing certain actions that other individuals can do." (P24)

"There are individuals who exhibit different behaviors, and different learning techniques need to be applied to them." (P22)

"I know that they have the right to education, and this is also supported by the law. I know that, in university education, in accordance with certain guidelines determined by the Council of Higher Education (YÖK), it is foreseen that specific conditions should be met for them to be equal with other students and to ensure equal opportunities for them." (P10)

"In reality, we don't have much information about the students." (P20)

"I don't know any students other than the one in my class." (P02)

The Awareness of Instructors Regarding Students with Special Needs

The themes and codes related to instructors' awareness of students with special needs enrolled in their courses are presented in Table 4.

Table 4. Awareness of Instructors Regarding Students with Special Needs in Their Classes

Codes	*f*
I was not informed about the student with special needs enrolled in my class	11
I learned about the student by seeing them in the classroom	*8*
The student with special needs informed me themselves by chance	*3*
I was informed by the school about the student with special needs enrolled in my class	10
I was informed about the student with special needs by the student themselves or their parent	4

Examining Table 4., it can be observed that participants were either unaware of the students with special needs registered in their classes, learned about them by seeing the students in the classroom, or were informed by the students themselves by chance. In cases where awareness existed, it was typically due to the school, the students themselves, or their parents' providing information regarding the student's special needs. Some of the participants' statements are as follows:

"We are conducting the course remotely, and for seven weeks, I had no idea. I only found out when there was an issue with the assessment assignment. I saw the student for the first time when they came to the laboratory for the initial class." (P19)

"On the very first day, when I came to class, as soon as we arrived at the first class, I noticed that my student had a visual impairment. I became aware of it through visual observation. I was not informed beforehand." (P05)

"I learned it in the special education class. When we were discussing special education, especially hearing impairments, the student mentioned that they had a hearing impairment." (P18)

"I later found out that he was hearing impaired. I used to think he was a very disinterested student in class... he always sat at the back. When I said something like, 'Did you forget how to do this?' he replied, 'I can't hear you, teacher.'" (P20)

"We receive information before the classes start. The disability support unit gathers information about the student and informs the teachers. If the student declares their disability on the registration system, we receive the information. We receive three notifications during the semester." (P21)

"Our disability support unit informs us after the student registers and applies to the relevant units." (P04)

"After course selections are completed, the relevant unit informs us about the student via email. Information explaining the student's situation and needs is conveyed through the system." (P25)

"At the very beginning of the semester, the disability support unit informs the student, assigns an academic advisor, and the academic advisor communicates with other instructors to explain the student's situation." (P14)

"His family came and talked to me when the classes started." (P02)

"The student themselves came and provided information before the class." (P17)

The Competence of Instructors in Providing Education to Students with Special Needs

Participants' competence in providing education to students with special needs, including their level of knowledge/education, adaptations they make, and the quality of

education they provide to students, is evaluated through themes and codes presented in Tables 5. and 6.

Table 5. The level of knowledge/education of instructors about teaching students with special needs

Codes	*f*
I received training/education	16
I took courses at the undergraduate or graduate level	*10*
I acquired knowledge through self-research	*9*
I gained experience by working with students with special needs	*4*
I acquired knowledge by attending events such as conferences, seminars, workshops	*4*
I received training provided by the disability support unit	*4*
I did not receive any training	9

Examining Table 5., the responses to the question about participants' knowledge/education levels in providing education to students with special needs show that 16 participants received training/education, while nine participants did not receive any training. Some of the participants' statements are as follows:

"I took a lot of courses in undergraduate, graduate, and doctoral education on delivering this education." (P06)

"I research what I can do for my students." (P11)

"I worked with young children in a special education center." (P04)

"I participated in the inclusive education program. It was an in-service training." (P24)

“The disability support unit provides in-service training... When I need information I want to learn, I ask the disability support unit about the disability status or the support I need." (P21)

Table 6. Adaptations made by instructors for their students with special needs

Codes	*f*
I make adaptations in exams and/or assignments	20
A helper/supervisor is provided and they are allowed to take the exam in a separate room	*13*
Extra time is provided for exams and assignments	*11*
Adaptations are made in exam questions	*8*
Questions are read aloud	*5*
I make adaptations in the course content	18
I make adaptations in course materials	*15*
I make adaptations and repetitions in course delivery	*13*
I make physical environment adaptations	14
I utilize peer-assisted learning	5
I do not make adaptations	5

Examining Table 6., it is observed that participants make various adaptations for students with special needs. Twenty participants mentioned making adaptations in exams and/or assignments. Among these, 13 participants mentioned assigning a helper/supervisor to the student and allowing them to take the exam in a separate room. Additionally, participants mentioned providing extra time for exams and assignments, making adaptations in exam questions based on the student's special needs, and reading exam questions aloud to the student. In terms of other adaptations, 18 participants mentioned making adaptations in the course content, which includes adaptations in course materials and course delivery. Fourteen participants make physical environment adaptations, six participants utilize peer-assisted learning, and five participants do not make any adaptations. Some of the participants' statements are as follows:

"We conduct his exam separately to accommodate his attention span and ensure that surrounding stimuli do not disturb him." (P23)

"For the student with attention deficit disorder, we received information that we should provide extra time for about two or three students, so we did that, granting them 50% extra time for exams." (P15)

"In written notes and exams, we use a larger font. In written assignments, we ignore spelling mistakes based on the student's disability." (P21)

"If we usually listen to recordings, for this student, we read aloud and pause where he wants us to." (P26)

"We enlarge the fonts for him, and he can record audio. In some classes, if he wants, he can use Braille alphabet. Buttons on the slides are also enlarged. We provide class notes." (P06)

"We request all our instructors in the class to at least, you know, when he can't hear you clearly with your mask on or if he's been absent for a while, speak a bit more slowly and clearly. If the student has a chronic illness besides his own disability, he may have the need to go to the restroom or take a break during class or exams, so we accommodate these needs. We have many verbal cues. I often engage in a continuous question-and-answer session during the class." (P03)

"Our classes are on the ground floor for easy access for students. We have chairs with arm set in the front rows for them." (P10)

"We try to create an environment that makes him comfortable through his close friends. We do activities together as a class, not individually." (P04)

"In course delivery, so far, no student has come to me and said, 'I have this issue, can you do this for me?'" (P16)

It has been observed that the participants employ various adaptations in examinations, including allowing the student to take the exam in a separate room, assigning an additional proctor or a reader to the student, and reading the exam questions out loud. Adaptations specific to the student's unique needs in exam questions are also made, such as using larger fonts, colored paper, shorter questions, questions that require short answers, or offering multiple-choice questions instead of written ones. Electronic devices are also utilized in examinations, allowing students to type their answers and subsequently print them out. Additional adaptations include providing study sheets before exams, granting extra time for exams and assignments, allowing electronic submission of assignments instead of hand-written submissions, and requesting that classroom activities be submitted as homework assignments. It has been observed that the adaptations made by instructors in course content include adaptations in instructional materials (such as visually rich course content, allowing students to record audio, utilizing large font sizes in written materials, preparing and sharing supplementary notes, sharing comprehensive lecture notes, distributing course resources in PDF format, etc.); adjustments made in the course presentation (such as assigning appropriate roles in practical courses depending on the inadequacy situation, remaining within the student's line of sight for lip reading, providing the opportunity for the student to communicate via email when they have questions, allowing students to express themselves in class without a time constraint, and cautioning the student when necessary so as not to disrupt the flow and content of the course); and increased repetition by the instructor course delivery. Adjustments made by instructors in physical environments include modifications within the classroom setting, such as rearranging tables and chairs to allow the student to move more freely and seating the student closer to the instructor if they rely on lip-reading. Classroom selection is also tailored to meet the student's specific needs. For example, if the student has physical disabilities, a classroom on the first floor may be chosen, and if there is a hearing impairment, a classroom equipped with an FM or sound induction system may be utilized. Participants who benefit from peer-supported education receive peer assistance in various forms: assigning a student partner during in-class exercises, assigning a student to accompany them in practical lessons, conducting activities in team formats within the classroom rather than individually, and providing a student partner during assignment presentations to offer support.

Quality of Education Provided by Instructors to Students with Special Needs

Upon examining the responses regarding the quality of education provided to students with special needs, it was observed that 13 participants find the education they provide to be adequate, while 12 participants do not feel they are sufficient.

Table 7. Instructor's views about the education they provided to students with special needs

Codes	*f*
I do not feel I am sufficient in the education I provide	13
I feel I am sufficient in the education I provide	12

Some of the participants' opinions are as follows:

"I have not received training on teaching students with special needs, so I need to learn about this subject." (P11)

"There have been areas where I felt very lacking I don’t know how to educate individuals with hearing and visual impairments in language learning. We don’t know how to find Braille books." (P26)

"I have been able to be there for them emotionally and academically, and I'm satisfied with myself since their reactions were also good." (P14)

“Considering the education I have received; I think I am better at analyzing their needs. In other words, I know how to behave toward an individual with autism or how to behave toward someone with Down Syndrome." (P23)

Quality of Services Provided by Higher Education Institutions to Individuals with Special Needs as Perceived by Instructors

Instructors' opinions on the quality of services provided to individuals with special needs by the higher education institutions they work at have been collected. A theme regarding the quality of services provided to students with special needs by the Higher Education Institute has been established. The theme and codes are presented in Table 8.

Table 8. Instructors' Views on the Quality of Services Provided to Students with Special Needs by the Higher Education Institutions They Work At

Codes	*f*
I find the services provided by the higher education institution to be of high quality	14
I find the student-focused academic or social activities to be of high quality	*8*
I find the arrangements in the physical environment to be of high quality	*8*
I find the work of the Disabled Student Unit to be of high quality	*5*
I find some services to be of high quality and others to be of low quality	6
I do not find the services provided by the higher education institution to be of high quality	4
I have no opinion	1

Upon examining Table 8., it is found that 14 participants consider the services for individuals with special needs provided by their institution as high-quality. Six participants find some services to be high-quality and others to be of low quality, four participants do not find the services to be of high quality, and one participant has no opinion. The majority of the participants find the services provided to students with special needs at their institutions to be of high quality, particularly in terms of student-focused or social activities. Similarly, they find the physical environment adjustments and the work of the Disabled Student Unit to be of high quality. Some of the participants' statements are as follows:

"We use a system where lectures can be replayed and listened to again, lecture notes can be accessed, subtitles can be added, and you can enlarge the font size. Adaptations are easily made as the university infrastructure is suitable." (P21)

"Our department underwent significant construction last summer. Our doors were widened for wheelchair access, ramps were built everywhere, and an elevator was installed. I think the necessary facilities have been provided. Specifically, for someone with a physical disability, there's no class, no professor's office, nothing that they cannot access. There's a sound at the door in the cafeteria that bothers us; it's apparently to indicate the door's location for the hearing-impaired." (P16)

"The accessibility coordinator works well. Frequent discussions with students occur focusing on individual needs, suggestions, and complaints. Professors are regularly sent informative emails. Individual meetings with faculty are conducted. They are carrying out efforts to increase awareness and understanding." (P04)

"I don't think we are sufficient in terms of physical architecture If we're talking about an accessible campus, every corner of the campus should be ergonomic for an individual with a physical disability." (P11)

P14 stated the service he considers high quality as follows: "Particularly, efforts related to our Accessibility Unit have significantly accelerated over the past 3-4 years. The establishment of this unit, along with having a representative in every faculty, has notably enhanced our awareness on this matter." "In terms of services deemed to be of low quality, Faculty Member P14 stated: 'Although it would perhaps be beneficial for all our buildings to be more highly friendly for individuals with disabilities, our buildings are quite old.'"

P03 noted both strengths and weaknesses in services, stating: 'We have both earned the 'Orange Flag' and made strides in terms of physical accessibility, even winning awards for these efforts. However, this is not enough. While ease of physical access is indeed crucial, there are gaps in the availability of educational resources. For example, the absence of any resources in Braille for our students with visual impairments reveals a shortfall on our part.'"

“Basic walking, vision, and mental health services. All are insufficient." (P06)

"I don't have much information about the services." (P17)

Challenges Faced by Instructors at Their Higher Education Institutions

Instructors' perspectives were obtained concerning the challenges they face in higher education institutions regarding students with special needs. A theme around these challenges has been developed. These themes and their respective codes are presented in Table 9.

Table 9. Instructors' Thoughts on Challenges Encountered in Their Higher Education Institutions

Codes	*f*
I experience problems	22
I experience problems during lectures	*11*
I experience problems during assessment	*9*
I experience problems due to physical conditions	*6*
I experience problems in communicating with the student	*4*
I don't experience any problems	3

Upon reviewing Table 10, based on responses to the interview questions, 22 participants indicated they experienced problems during the educational process at their higher education institution, while three participants mentioned they did not experience any problems. Eleven participants mentioned they experienced problems during lectures due to reasons such as the inability to provide support during practical lessons, the lack of knowledge regarding the level of a student's impairment which led to difficulties in making adaptations, student absenteeism, students not being able to adapt to program lessons because of their impairments, students lagging behind their peers in class activities, and the faculty's inability to cater simultaneously to students with special needs and the rest of the class, among other issues. Some of the participants' statements are as follows:

“In classes like Material Design, students with disabilities face challenges in design and creative thinking according to their type of disability. Practical lessons are problematic. There are difficulties in one-on-one lessons involving pre-service teachers with special needs." (P21)

"Students may choose not to attend class or even fall asleep during it. They can struggle with theoretical subjects. Lack of interest or understanding can lead them to make noises, talk to themselves, or lay their heads down and sleep. These behaviors can disrupt the concentration and motivation of the instructor and other students." (P07)

"I have a visually impaired student, and the subject of instructional technology is a very visual one. Perhaps he could have been exempted from it. Alternatively, we could have considered different ways to present the material. How do you expect someone to design something they can't see?" (P19)

"Depending on the severity of the situation, there can be instances of high stress, which can lead to sudden outbursts. There's definitely no violence involved, but these abrupt emotional spikes can occur." (P22)

"Students might lag behind a bit, meaning we have to proceed more slowly with them compared to the rest of the class. This might be due to their inability to see or hear. For instance, when I have a class of 25 students, finding the right balance becomes challenging." (P27)

"When the student is unable to scan the text, we can't assess that skill. The student can't progress by reading at their own pace; someone else has to read for them, or they have to read it slowly and magnified, making it difficult to assess their knowledge. They might be able to pronounce words, yet they don't know how to spell them." (P26)

"I faced a challenge during an exam when I encountered a student whose special needs I was unaware of. We couldn't conduct the exam, and I had to offer a re-examination." (P28)

"While evaluating, should I be lenient? For instance, should I award a BB grade instead of the DD they might actually deserve? There are such dilemmas." (P15)

"The student tried to gain sympathy. They did this even during exams, saying things like, 'I can't remember the answer; can you mark it for me?' There were various such requests." (P19)

"Classes were mistakenly assigned to other floors." (P10)

"We don't have a physical environment where my visually impaired student can walk independently. There's a significant need for technological support." (P23)

"At first, I attributed his communication difficulties to other reasons. However, when I learned about his hearing impairment, I realized he probably couldn't hear my questions, which is why there was no interaction in the classroom." (P18)

"Perhaps there's a need for one-on-one attention, especially in crowded settings or laboratory classes. The student approached me during the breaks, so there wasn't any problem." (P17)

Reasons for the Problems Experienced by Instructors

The views of instructors have been gathered regarding the issues they encounter in relation to their students with special needs. A theme concerning the reasons for these problems has been established. The theme and codes are presented in Table 10.

Table 10. Views of instructors on the reasons for the issues they encounter

Codes	*f*
I believe I encounter these problems due to the type of student's disability	8
I believe I encounter these problems since I don't have sufficient information about students with special needs	6
I believe I encounter these problems because the necessary conditions for students with special needs are not met in higher education institutions	6
I believe I encounter these problems due to societal prejudice	3
I believe I encounter these problems as sufficient information and proper guidance are not provided to students with special needs	3

Upon examining Table 10., after investigating the issues faced by participants working in higher education institutions, a survey question was posed to gather their views on the reasons behind these issues. Analyzing the obtained data, eight participants stated that the issues arise due to the disability type of the student. Eight participants stated that the issues arise due to the inadequacy type of the student. Seven participants mentioned they encounter problems since they lack sufficient knowledge about students with special needs. Six participants believe that they face challenges as the necessary educational conditions for students with special needs are not provided. Three participants mentioned that the problems arise from societal prejudices, and three other participants stated that issues arise for students with special needs are not given sufficient information and proper guidance. Some of the participants' statements are as follows:

"The reason for their inadequacy is not just because of the student's hearing impairment. In addition to hearing, they also have intellectual problems. The biggest problem we encounter is multiple disabilities." (P03)

"Some students may not want to attend the class. Perhaps their psychology is not suitable at that moment, or they may want to do something else. If they cannot express this, they might cause behavioral problems in the class, saying they want to leave, and if they leave, they will be marked absent." (P07)

"We don't know how to provide language education to a student with special needs due to their disability." P20

"The source of the problem is that if the students have a special need, I should have known about its weeks before the class because I already have to make these adaptations when the class starts." (P26)

"They don't want to deal with it in conservatories, or they might not even know. We don't have the personnel to teach the class." (P07)

"For instance, we don't have a physical environment where my visually impaired student can walk on their own." (P23)

"The biggest challenges are faced in practical classes. For example, in a group practical lesson, pre-service teachers go to the practice one-on-one with a child. When they go to the practice with a child, they face communication problems. The institution they go to might not want them. We have difficulty finding institutions. They say, 'This student has a hearing impairment.' They tell, 'This student has a physical disability.' Other parents don't want the children to see them. They don't want to work with them." (P21)

"It's very important to direct the child to the right profession. So now, if our student can somehow pass the classes, they become an adult who shows normal development after graduation. Yet, they still cannot manage to even talk with an individual or maintain a conversation. In university choices, it's very important to choose the right program and the right department. Recognizing the child's interests, abilities, and hobbies is quite important." (P03)

Suggestions from Instructors for Improving the Education of Students with Special Needs

Suggestions have been gathered from instructors regarding how to improve the educational experiences of students with special needs. A theme concerning suggestions for enhancing the education of students with special needs has been formulated. The theme and codes are presented in Table 11.

Table 11.2 Suggestions from Instructors for Improving the Education of Students with Special Needs

Codes	*f*
Academic and administrative staff should receive training about individuals with special needs	19
Existing conditions of the school should be improved	13
Physical conditions of the school should be improved	*6*
Administrative functioning of the school should be improved	*5*
Activities of the Disabled Student Unit should be improved	*4*
Social awareness activities should be carried out	9
All kinds of support should be provided to students with special needs according to their needs	8
Other	2

Upon examining Table 11., it can be observed that 19 participants suggested that academic and administrative staff should receive training about individuals with special needs in order to improve the education of students with special needs. Thirteen participants indicated that the existing conditions of the school should be improved for students with special needs. Nine participants suggested that social awareness activities should be

conducted. Eight participants recommended that all kinds of support should be provided to students with special needs according to their individual requirements. Some of the participants' statements are as follows:

"In-service trainings should be provided to inform the university's academic and administrative staff. Information about the types of disabilities and the educational adaptations and approaches that should be used must be given." (P05)

"Academic and administrative staff should receive training in this area. For instance, separate trainings could be provided for assessment and evaluation, as well as for communication It would be beneficial if a seminar or training were given to the instructors before the academic term starts. Considering my own students, I would like to know about their needs even before they communicate them to me." (P11)

"For example, classes can be equipped with technical facilities; however, there are assistive technologies that could help individuals with special needs. The environment can be integrated with such assistive technologies. For instance, door sensors could be installed, which would be useful for all individuals, much like ATMs and lavatories. The principles of universal design should be applied." (P18)

"Educational institutions should be prepared. The system that the university has established for students with special needs to be made efficient and functional." (P09)

"Both students and instructors should be informed." (P25)

"Awareness-raising activities could also be increased throughout the university." (P18)

"The psychological support and employment opportunities offered to students with special needs should be increased. I think it would be appropriate to create a social environment where students with special needs and students with typical development can come together." (P05)

"Choosing a profession based on the child's interests and abilities in both high school and university is my utmost priority. I argue that families and experts in this field should direct the student and the child accordingly. Grading and group distribution should be done for students with special needs without discrimination, otherwise, we end up marginalizing them." (P03)

Discussions

Based on the findings of this study, this chapter discusses the competencies of instructors in higher education institutions with students with special needs in their courses. The discussion also covers their perspectives on the quality of the higher education institutions where they work, the challenges they face, and their proposed solutions.

Despite more than half of the participants indicating that they have some knowledge about different types of disabilities, the challenges, and the needs of students with special needs, it becomes evident from the gathered data that the instructors are, in reality, not adequately informed or equipped. Nearly all participants reveal that they are unable to make the necessary adaptations in the teaching process due to gaps in their knowledge. Moreover, they are largely unaware of the legal rights of students with special needs and struggle to communicate effectively with these students (Hong and Himmel, 2009; Özsökmen, 2019; Partici, 2018). Participants lacking comprehensive knowledge about students with special needs were found only to have as much information as what was provided to them regarding their own students. This information is limited to basic facts about physical disabilities, cognitive disabilities, and neurodevelopmental disorders. It is seen in the findings of the study that these participants obtained their knowledge through hearsay and personal experiences. The lack or limited knowledge of instructors regarding the types and severity of disabilities of students with special needs can lead to issues. These issues include students not benefiting from suitable course materials, the necessary preparations not being made, the lack of protective measures, the violation of legal rights, and challenges in accessing an accessible learning environment. If the nature and severity of a student's disability are unknown, it can lead to problems in making necessary academic adjustments and ensuring student accessibility, among other issues. In relation to these challenges, a study conducted by Karakuş et al. (2017) supports the findings of this research, suggesting that instructors need to be better informed about individuals with special needs.

It has been observed that more than half of the participants were not informed about having a student with special needs enrolled in their classes. Such lack of information prevents instructors from making the necessary preparations and adaptations prior to classes, securing appropriate teaching materials, making physical accommodations in the classroom, and effectively communicating with their students. Yet, in higher education institutions, information systems, student affairs, and offices for students with disabilities can inform instructors about students with special needs enrolled in their courses. In this study, however, only ten participants were notified about having a student with special needs in their classes. It is known that higher education institutions have systems in place where information regarding the special needs of students is entered at the time of university registration. The expansion of these systems can enhance the notification of instructors about students with

special needs. Thus, through a more accessible platform, it is possible to prevent potential problems that students with special needs may face.

More than half of the participants stated that they received training/information on teaching students with special needs. The findings obtained from the study show that although the participants stated that they had previously received training on individuals with special needs, they were sometimes unable to cope with the problems they mentioned. This situation suggests that faculty members at higher education institutions need more training regarding individuals with special needs and academic adaptations.. The interviewed instructors indicated that these challenges could lead to student absenteeism, distancing from their departments, and even dropping out of school. Instructors try to contribute to the higher education of their students with special needs through their own efforts, however, they acknowledge that they fall significantly short in providing the necessary support that should be given to these students in higher education settings. Similar results were found in a study by Gaad and Almotairi (2013), where educators did not undergo professional training on communication with and instruction for students with special needs. Educators adopted a trial-and-error approach, allowing the students to "educate" the educators as they tried to provide education for individuals with special needs. These similar findings indicate potential shortcomings in planning, implementing, and evaluating appropriate educational content if instructors do not undergo the necessary training. However, regardless of whether instructors have students with special needs in their courses, it is expected that they should be knowledgeable about these students' legal rights, necessary academic adjustments, and communication methods. Having such knowledge is believed to enhance the readiness and preparedness of instructors (Bourke et al., 2000; Gibbons et al., 2015; Hughes et al., 2016; Holmqvist et al., 2019; Khattab Shahleh, 2021; Love et al., 2015; Zhang et al., 2018). For instructors teaching students with special needs to be adequately equipped, it is suggested that they consult the relevant units within higher education institutions to address areas where they fall short. Additionally, it is important that periodic assessments be conducted to examine the needs and challenges faced by both instructors and students with special needs in higher education settings. The subsequent actions and preventive measures that need to be taken should be communicated to higher authorities for effective resolution. This approach is thought to provide an integrated and accessible educational environment for students with special needs and is corroborated by existing literature (Burgstahler, 2020; Reardon et al., 2021; Rose et al., 2006; Gonçalves et al., 2014; Morina et al., 2017).

Evaluating the adaptations made by participating instructors, it becomes evident that not all are aware of the necessary adaptations outlined in the regulations for special education and higher education for disabled students. Instructors appear to make some modifications based on requests from students with special needs and advisories from units specializing in disabled student services. However, even when the adaptations are accurate, their implementation is often flawed. For instance, regulations stipulate that additional exam time granted for specific disabilities should not exceed one-third of the total exam duration. Yet, it has been observed that some instructors either allocate significantly more additional time or fail to provide any extra time at all, thereby not adhering to the prescribed guidelines. Another example pertains to the assessment of reading skills in foreign language instruction for a student with a visual impairment. In such cases, if the instructor reads the text aloud to the student, the assessment actually tests listening skills rather than reading skills. In scenarios like this, it may be necessary either to exempt the student from specific sections of the course or to employ an alternative evaluation tool that takes into account the student's actual capabilities. In another example, a student with Autism Spectrum Disorder was provided with questions nearly identical to those on the upcoming exam, thereby facilitating a high score based on rote memorization. In such cases, the reliability of the assessment is observed to be compromised. These examples indicate a lack of compliance with regulations, legal rights, and appropriate academic adaptations. Moreover, it has been found that the majority of the instructors make adaptations primarily in exams and assignments, and often make these adjustments right before the exams, feeling compelled due to laws and regulations. It has been observed that instructors lack awareness about what kinds of adaptations are necessary for students' exams and what alternative options exist. For instance, they are not aware that instead of using a proctor, accessible reading can be facilitated through electronic means or that an alternative to handwriting might include using a computer keyboard or dictation to enable an environment where the student feels more comfortable and uninhibited in self-expression. Exposing students with special needs to exams, test environments, and evaluation methods that are not tailored to their specific needs can adversely impact their academic performance. To avoid such outcomes, it is essential that adaptations are made according to the type of disability and the needs of individual students. The findings obtained from the study show that the adaptations made in teaching materials are often based on the instructor's experience with their students, and it has been noted that they are generally aware of adjustments only for their own students. Besides, participants also have expressed feeling

inadequately equipped to make suitable adaptations for students with different types of disabilities (Accardo et al., 2019; Barnard-Brak et al., 2010; Chan, 2016; Harrison et al., 2013; Lefler et al., 2023; Ju et al., 2017). It should not be expected that students with special needs arriving at higher education institutions are fully aware of all possible adaptations that can be made for them, nor should the responsibility lie solely with them to communicate these needs to their instructors as they take steps toward becoming independent individuals in higher education institutions, it is the responsibility of the faculty to provide an environment and curriculum tailored to their needs and to support them accordingly. Otherwise, it appears unlikely for students with special needs to achieve academic and social success and, subsequently, to become independent individuals.

Instructors often feel ill-equipped to teach students with special needs, primarily as they haven't received adequate training on the subject. The sentiment of inadequacy extends to making academic accommodations for these students. It's seen that their knowledge is limited, and they are uncertain about how to accommodate students with disabilities different from those they have previously encountered. Similar conclusions have been drawn from studies conducted in Finland. These studies indicate that educators in higher education are keen to understand how to identify the specific needs of students with disabilities, especially when these students haven't been formally diagnosed or haven't disclosed their condition to their instructors. While this lack of preparedness may be due to insufficient knowledge in identifying and providing education for students with special needs in higher education, it also reveals that inclusive/integrated education in higher education is not always readily accessible (Karakuş et al., 2017). Some participants have indicated that, although they make academic accommodations, these efforts are not sufficient for supporting the student both academically and professionally. The reason cited is that the chosen field of study in higher education may not be suitable for the student with special needs, and due to the student's existing deficiencies, they encounter challenges in academic and vocational acquisition. Consequently, it is imperative for universities to provide expert guidance and support to students with special needs when they are choosing their majors. This informed guidance will enable these students to enroll in departments that align with their competencies, thereby facilitating their academic success and eventually empowering them to become independent individuals with careers post-graduation (Chan, 2016; Christensen, 2020; Jones and Krumsvik, 2008; Sevinç and Çay, 2017). In a study exploring the reasons behind the academic department choices of university students with visual impairments, it is revealed that these students predominantly opt for

departments with a focus on verbal skills. This preference is attributed to the lack of adequate curriculum adaptations for quantitative subjects during their primary and high school educations. As a result, these students are more inclined towards verbally oriented fields (Partici, 2018). Although nearly half of the participants claimed they had implemented the necessary academic accommodations and adjustments, received positive feedback from students, complied with regulations regarding students with disabilities, and considered themselves competent to teach in the field of special education, only three participants stated that they had not faced any issues in educating students with special needs. This discrepancy highlights a potential inconsistency between educators' perceptions and the reality of their practices.

In the study conducted across seven universities, it was found that more than half of the instructors considered the implemented measures to be adequate, whereas nearly half did not find their institutions to be qualified and made suggestions for enhancing the educational experience of students with special needs. These suggestions largely consisted of providing training to academic and administrative staff, improving existing facilities, conducting societal awareness campaigns, and offering comprehensive support tailored to the students' needs. These recommendations underscore the necessity of improving the quality of higher education institutions where these students are enrolled. According to the laws and regulations regarding higher education that encompass individuals with special needs, if institutions' academic and administrative personnel do not implement the regulations ensuring the higher education rights of students with special needs, it is believed that the students are adversely affected In the literature, it is clearly stated that institutions must implement legal regulations to create environments in higher education that support the education and training of students with special needs and provide opportunities for independent living skills (Coriale et al., 2012; Karakuş et al., 2017; Kaya, 2019; Mengi, 2019; Sevinç and Çay, 2017; Tekin, 2019; Yusof et al., 2020).

The research conducted across seven different universities reveals that almost all of the nine instructors involved encounter challenges. Despite regarding their instruction and affiliated institutions as competent, these educators reported facing difficulties. Participants emphasized that many of these issues arose during lessons, pointing to communication barriers between students and instructors, as well as struggles in making academic adjustments. Such conditions are believed to potentially have a negative academic impact on students with special needs. Challenges also extend to evaluation procedures like exams and

assignments. This is perceived to arise from faculty's reluctance or inability to utilize appropriate assessment tools, make the necessary test or assignment modifications, and assign the necessary aids such as proctors or scribes for the students. Additionally, physical conditions were also identified as an issue. The lack of accommodations to make the school or classroom settings physically accessible for the students is believed to be a primary cause of these challenges. When participants were asked about the possible causes of the challenges they faced, the responses showed a similar distribution across the board. A significant number of participants pointed to the specific type of student's disability as a major factor leading to challenges. Instructors attributed the issues they faced to various reasons, including lack of adequate knowledge about the student's condition, the institution's failure to provide necessary accommodations, societal prejudices leading to challenges, and the absence of sufficient information and proper guidance for students with special needs. The causes of these problems cited by the participants appear to align closely with the issues reported in the existing literature from our country (Gündoğar, 2020; Karakuş et al., 2017; Mengi, 2019; Özsökmen, 2019; Partici, 2018).

Participants have suggested that in order to improve the quality of education for students with special needs, both academic and administrative staff should be educated about individuals with special needs. This recommendation is consistent with findings in the existing literature (Holmqvist et al., 2019; Karakuş et al., 2017; Muhamad Zaki and Ismail, 2021; Özsökmen, 2019; Partici, 2018). Thus, it is believed that academic and administrative personnel in higher education institutions would be better equipped to communicate with students with special needs, observe their legal rights, and successfully implement academic adaptations. This includes classroom practices and activities, the physical environment of both the classroom and the institution, and the assessments through homework and exams. Such preparedness is expected to alleviate challenges and contribute more effectively to the education of students with special needs. Instructors recommend improvements in the physical accessibility of their institutions, administrative processes, and the operations of the Units for Students with Disabilities. They also advocate for the provision of psychological, social, and housing support, as well as scholarship opportunities tailored to the needs of students with special needs. In this context, it is believed that students with special needs will not face any problems related to accessibility within the institution where they study. If the administrative operations and the activities of the Disabled Student Units are enhanced, from the first day they enroll in the university until the day they graduate, they will be able to

attend their courses without any issues. Their requests and suggestions are expected to be addressed more swiftly; they can participate in social activities and benefit from the necessary psychological, social, and housing support. Lastly, the participants recommend that awareness-raising activities be conducted to include faculty, administrative staff, and students undergoing typical development in the institutions where they work. These proposed awareness activities are considered extremely important for the full integration of students with special needs into the institutions where they study. They aim to facilitate the effective implementation of inclusive education initiatives and, in short, enable full integration into societal life.

Considering the National Action Plan on Educational Practices through Mainstreaming/Inclusion, published in 2022-2026 by the General Directorate of Special Education and Guidance Services in our country, it is assumed that increasing the qualified participation of students in general education environments will enable them to come to higher education systems more easily and more adequately (Özel Eğitim ve Rehberlik Hizmetleri Genel Müdürlüğü, 2023). It is recommended that similar practices can be planned at the higher education level and a plan such as the Mainstreaming/Integration Plan be prepared in higher education. At the same time, it is thought that students who have not yet started university will be informed together with their families and placed in the right programs and departments under mainstreaming and integration practices, and by taking these action plans into consideration, individuals with special needs will be guided correctly before university and ensure that they study in appropriate university departments.

Conclusion and Suggestions

The study examines the opinions and suggestions of instructors working in universities in İzmir regarding their experiences, challenges, and proposed solutions concerning students with special needs enrolled in their courses. To generalize the findings, the same study can be replicated in different cities with different participants and researchers. Similar studies can also be conducted with administrative staff or typically developing students who are enrolled in higher education institutions. Research employing different methodologies and larger sample sizes can also be conducted. Based on the needs expressed by instructors, studies could explore the effectiveness of education programs designed by special education experts to enhance the academic success of students with special needs. Research can be conducted with instructors who have not previously had students with special needs in their classes, and

the findings can be compared with the results of this study. A comprehensive study could be carried out to evaluate the competence of instructors in teaching students with special needs.

Typically developing students, as well as academic and administrative staff in higher education institutions, can be informed about students with special needs through awareness-raising activities. Training can be provided at regular intervals to instructors in higher education institutions on in-class applications, assignments, assessments, and possible adaptations in the physical environment of the class and institution for students with special needs Higher education institutions can take necessary measures to ensure accessibility tailored to the needs of students with special needs.

Compliance with Ethical Standards

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Ayşegül GÖKDAĞ contributed to determining the subject of the study, collecting the data, analyzing the data and reporting the study. Özge ÜNLÜ contributed to the research design, data analysis and reporting of the study.

Research involving Human Participants and/or Animals

The Social and Humanities Scientific Research and Publication Ethics Committee of İzmir Democracy University has determined that this research is ethically appropriate, as per their decision number 2022/07-05, dated 06/07/2022.

Yükseköğretim Kurumlarında Özel Gereksinimli Öğrencisi Olan Öğretim Elemanlarının Karşılaştıkları Sorunlar ve Çözüm Önerileri

Özet:

Araştırmanın amacı yükseköğretim kurumlarında derslerinde özel gereksinimli öğrencilere eğitim sunan öğretim elemanlarının karşılaştıkları sorunları ve bu sorunlara getirdikleri çözüm önerilerini belirlemektir. Amaç doğrultusunda, öğretim elemanlarının özel gereksinimli öğrencilere ilişkin bilgi düzeylerine, karşılaştıkları sorunlara, bu sorunların sebeplerine ve yaşanan sorunlara yönelik çözüm önerilerine, özel gereksinimli öğrencilerine verdikleri eğitime ilişkin kendilerini ve kurumlarını değerlendirmelerine yönelik görüşlerine başvurulmuştur. Araştırmada nitel araştırma yöntemlerinden betimleyici fenomenolojik desen kullanılmıştır. Araştırmanın katılımcılarını Türkiye'nin İzmir ilindeki yükseköğretim kurumlarında görev yapmakta olan ve derslerinde özel gereksinimli öğrencilere eğitim sunan 25 öğretim elemanı oluşturmaktadır. Veriler yarı yapılandırılmış görüşme formu kullanılarak toplanmış ve betimsel içerik analizi yöntemi kullanılarak incelenmiştir. Araştırmanın bulguları öğretim elemanlarının derslerinde bulunan özel gereksinimli öğrencilerinin yetersizlik türleriyle ilgili yeterli bilgiye sahip olmadıkları, akademik uyarlamalara ilişkin kendilerini nitelikli hissetmedikleri, görev yapmakta oldukları yükseköğretim kurumunun erişilebilirlik açısından yeterli düzeyde olmadığı, akademik ve idari personelin farkındalığının düşük olduğu görülmüştür. Bulgular doğrultusunda farkındalığı arttırıcı çalışmaları, üniversitede görev yapan personelin engelli öğrencilerin özelliklerine ve yapılabilecek uyarlamalara ilişkin eğitimleri ve erişilebilirlik konusunda düzenlemeleri kapsayan çalışmaların yapılması gerektiği sonucuna ulaşılmıştır ve öneriler geliştirilmiştir.

Anahtar kelimeler: akademik uyarlamalar, öğretim elemanları, yükseköğretimdeki özel gereksinimli öğrenciler

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Research Article

In the Light of Current Problems in Education: TÜBİTAK Science Child Magazine and Building a Sustainable Future*

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Abstract – The aim of this study is to determine to what extent the texts in Bilim Çocuk (Science Child) magazine, which aim to contribute to the development of 21st century skills, recognized as one of the current issues in education, and address the globally shared agenda of sustainable development goals, support the goals of sustainable development and contribute to the scientific development of children that they can utilize in their educational process. In this study, in which qualitative research design was utilized, the data were obtained through document analysis, and the data obtained were tabulated and interpreted with percentages and frequencies. In the selection of the magazines to be included in the study, 72 issues published in 2016-2021, determined by criterion sampling method, which is one of the purposeful sampling methods, were analyzed. According to the findings of the study, it was determined that 92.59% of the texts in Bilim Çocuk magazine belonged to the informative text type and 7.40% to the narrative text type, and that the texts in the magazine were related to SDG 12 "Responsible Production and Consumption" among the seventeen global goals the most (n=31) and the least (n=1) to SDG 8 "Decent Work and Economic Growth". It is recommended to include diversity in the types of texts in the journal and to include other goals that are not yet included in the context of raising awareness about sustainable development goals and encouraging individuals and institutions to take action.

Key words: Sustainability, sustainable development goals, children's literature, 21st century skills.

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Introduction

Digital literacy, intensive thinking, effective communication, high productivity, spiritual and moral values are the five core domains of the 21st century (Trilling & Fadel, 2009). Reconsidering pedagogy for the 21st century is as significant as identifying the new competencies that today's students should develop. Far from developing students' critical thinking skills or autonomy, traditional approaches still rely on students to memorize or follow simple instructions. What students really need, in order to develop higher-order thinking skills, is to engage in meaningful inquiry-based learning that has real value and relevance for individuals themselves and their communities (Luna Scott, 2015, s. 2).

The qualities that 21st century students have to possess in order to embrace lifelong learning and become information literate are described in detail by the American Association of School Librarians (AASL) in the report titled "Standards for the 21st Century Learner" (AASL, 2009). According to this report, some standards known as "21st Century Learner Standards" were determined. These standards include 81 standards in four dimensions. These are: researching, thinking critically and acquiring knowledge (25 sub-standards), drawing conclusions, forming informed decisions, implementing knowledge in new situations and generating new knowledge (17 sub-standards), sharing knowledge, participating ethically and productively as members of a democratic society (19 sub-standards), and striving for personal and aesthetic development (20 sub-standards) (Gelen, 2017).

The basic principle is that mastery of core subjects and 21st century themes is essential for student success in today's world. Core subjects include English, reading or language arts, world languages; art; math; economics; science; geography; history; government; and civics. In addition to these subjects, schools are encouraged to promote much higher levels of understanding of academic content by integrating 21st century interdisciplinary themes into core subjects. These interdisciplinary themes are: Global Awareness; Financial, Economic, Business, and Entrepreneurial Literacy; Civic Literacy; Health Literacy; Environmental Literacy (AASL, 2009; Battle For Kids, 2019).

Barron and Darling Hammond (2008) state that real-world experiences combined with consistent participation and collaboration provide students with the opportunity to construct and organize knowledge; lead to detailed research, inquiry and analysis processes; and provide participants with the opportunity to communicate effectively. Based on these statements, this study was designed with the foresight that 4C competencies can be acquired

by children through children's literature products that both support students to become digital literate including 21st century skills and provide them with the opportunity to witness the real world experiences described by the researchers. In addition to developing students' 4C competencies, the scientific journals examined in the study also cover sustainability, which is one of the universal concerns of the world and an agenda item for all countries.

Children's literature publishing is a field that takes into account the cognitive, affective and social characteristics of the child and carries out their work with care, attention and meticulousness. Unlike literary products that appeal to adults, it is also important that children's literature products are capable of meeting the needs of children in terms of their skills and developmental characteristics. Therefore, both those who are interested in children's education and researchers working in this field expect from children's literature products that the values and information to be conveyed to the child reader can be conveyed by considering the child's perspective and child reality.

With the development of the printing press, the priority attributed to children's education increased, and with the widespread distribution of printed media organs that would meet the need for reading, it acquired a particular value. Children's newspapers and magazines, one of the elements of printed publications prepared for children, took their place among the important literary genres that would meet children's reading needs in this period. Through the texts presented to children in these newspapers and magazines, children are provided with information about different literary genres, the development of vocabulary is supported, scientific developments in the world can be traced, and a great contribution is offered to children's general culture levels and reading culture development (Şahin, 2009, s. 17).

Children's magazines have had an essential place among children's literature publishing materials from past to present. Yıldız and Karaca (2020) stated that the purpose of publishing children's magazines is to support children's development, that age and development are taken into account, the information presented in the magazine is prepared for children's interests and needs, and both texts that develop literary enjoyment and puzzles that aim to entertain children are included in children's magazines. It is believed that children's magazines should contain texts and activities that can create integrity with the child's formal and informal education. In this sense, children's magazines are a medium that can both contribute to the child's educational process and play an active role in the transfer of current and cultural information. While the texts in children's magazines enable children to acquire up-to-date

information, they also support the acquisition of reading habits (Karaca, 2022). Through the activities in the magazine, children are provided with the opportunity to develop their fine motor skills and interact with their peers while being entertained.

As the world rapidly evolves and transforms, so do the questions children raise. The many stimuli they are exposed to in their environment also alter the way they feel and think. Especially the 7-12 age group can experience some transformations in the way they perceive the world through social media, media outlets and social responsibility projects that they interact with during formal education. In the children's literature products prepared for this age group, new life situations fictionalized from a child's perspective in works written for them by authors and illustrators who prioritize their transformation with the world shed light on new questions that need to be answered in their minds. Children are asked questions such as "What can I do to love and protect nature?", "How can living species be taken under protection?", "What kind of negativities await us in life if living species are not taken under protection?", "Why should I be sensitive to the living creatures and nature around me?" or "Can life be prolonged thanks to the smart chip that is said to be able to identify the microbe in a short time?", Can wearable technological products make our lives easier but also bring some problems?", "How can I introduce climate action to my environment?", "What changes can I make in my school and home to become a responsible consumer?". Children's magazines should encourage children to think about the answers to these and similar questions, stimulate their imagination, and provide a natural learning environment in which they can support the adoption of a sensitive approach to the universe, their environment and living things. In our country, the magazine Bilim Çocuk (Science Child) published by TÜBİTAK Publications, which published its first issue in January 1998, has an important place among existing periodicals where children can seek answers to similar questions.

Published by TÜBİTAK Publications, Bilim Çocuk (Science Child) is a magazine that contains texts that contain scientific information that encourages children to think, question, criticize and research, and targets primary school students in the 7-12 age group, as well as preschool children and their parents. The aim of the magazine can be expressed as "to make children love science from an early age by telling them about science, the world and the universe, to demonstrate that science is a part of life, to raise the desire to do research, to ask questions, to be curious and to read" (Dedeoğlu et al., 2011).

When the content of the journal is examined, it is observed that in each issue there are current and scientific topics that are related to the previous issue, titles within the framework of a specific theme, and some sections with texts and activity examples appropriate to that theme. The common headings in each issue are: the section titled "What's New? " section with current scientific information, the cartoon series "Stories of a Scientist with Bagel and Cheese", which includes information about a scientist and his contributions to science, the book promotion section "A New Book", which includes the introduction of a book suitable for the age level, the writing column "Let's Ask and Answer", which includes the answer to a question about a subject that one of the readers is curious about, and the section "Sky Diary", which includes astronomy information, There are activity pages titled "Let's Have Fun Thinking", "Science at Home", "Wonders in Boots", "Letter Box", "From Your Observation Notebook", which include examples of various activities; the "From You" section, which includes written or visual works sent to the magazine by readers to share their feelings and thoughts; and the "Answers" section, where the correct answers to the activities in the magazine are presented to readers.

In recent years, there has been a socio-ecological change and transformation in the world. It is inevitable to establish a balance in this substantial change that cannot be ignored and to prevent some of the problems arising from the change in question. At the same time, future generations as well as today's people should be able to benefit from the existing resources. Considering all these, the countries of the world have certain responsibilities in the socio-economic field. These responsibilities have become even more significant with the universal call to action called the Sustainable Development Goals (SDGs), which was published in January 2016 and signed by 193 United Nations member states. The goal of the SDGs is to produce solutions and make improvements to the aforementioned issues, which have been determined until 2030 and gathered under 17 main headings. The 17 main topics in this universal call for action are as follows: "End poverty, end hunger, health and quality of life, quality education, gender equality, clean water and sanitation, accessible and clean energy, decent work and economic growth, industry, innovation and infrastructure, minimization of inequalities, sustainable cities and communities, responsible production and consumption, climate action, life in water, life on land, peace, justice and strong institutions, partnerships for purposes". These goals are global in nature as they concern all of humanity. Due to this characteristic, the steps to be undertaken for each goal will ensure the realization of the call to action and will make it possible to achieve these goals. In order to become an

aware, sensitive and conscious society, it is necessary to ensure that the next generation is informed about the current global problems and possible solutions to reach the goals set for possible solutions. As stated by Yapıcı (2003), "the only way for sustainable development to move from being an initiative to being put into practice is to raise individuals who believe in the concept of sustainable development and adopt it as a philosophy of life." (s. 226).

Therefore, while informing today's children, the adults of tomorrow to whom this world we live in is entrusted, about these issues, it is possible to benefit from written sources such as children's magazines that support them in acquiring a reading culture as well as visual media organs. Children's magazines have both current and universal qualities that inform children about global problems. For this reason, they are publications that encourage the acquisition of knowledge by generations with high levels of awareness, consciousness and sensitivity to what is happening. Together with the presentation of scientific information, these publications can be considered as a suitable type in terms of children's publishing that keeps the child's sense of curiosity active, gives them the responsibility of thinking and questioning, and develops their ability to analyze and problem-solve.

Purpose and Importance of the Study

When the field literature is examined, studies can be encountered that evaluate children's magazines in terms of their relationship with basic language skills in Turkish language lessons (Tanrıkulu, 2021), their connection with science concepts (Aksüt, 2021), their approach from a perspective of values (Tekin Bahrilli & Göloğlu Demir, 2021), their alignment with 5th-grade social studies curriculum outcomes (Gez & Ekiz, 2021), the connection of science-related content with the history of science (Yavuzoğlu & Pektaş, 2020), the associability of magazine content with lessons (Tanrıkulu, 2020), a general exploratory study (Yıldız & Karaca, 2020), the relationship between gender role representation and media (Yiğitbaşı & Sarıçam, 2020), fundamental principles of children's literature (Demirdal, 2019), the transfer of values and alignment with primary education curriculum (Güler, 2019), children's rights (Pembegül, 2019), the value of patriotism (Yılmaz & Duman, 2018), and strategies for constructing gender roles (Gürkan, 2017).

However, when the academic studies previously conducted in the field of education and sustainable development goals are examined; it is observed that there are some studies conducted in terms of teachers' values and beliefs towards the education process (Tekin, 2021), science teaching undergraduate students' attitudes towards the environment with

documentary filming activity (Aslan Efe, Yücel & Efe, 2020), metaphorical perceptions of prospective primary school teachers (Kaygısız, 2020), social, environmental and economic dimensions (Gedik, 2020), curriculum analysis of the science course (Ateş, 2019) and the relationship with the education process (Yapıcı, 2003). When the existing studies were examined, it was observed that the concepts of children's magazines and sustainable development goals were not examined together in any study. When the literature studies are examined, it is believed that the current study will make a unique contribution to the field. Within the scope of the research, the question "To what extent do the texts in Bilim Çocuk magazine support SDGs?" and the following sub-problems are addressed.

Sub-Problems of the Research

1. What is the distribution of text types that include SDGs in Bilim Çocuk magazine?

2. How are the texts in Bilim Çocuk magazine distributed according to SDGs?

3. Does the frequency of the texts in Bilim Çocuk magazine to include SDGs differ according to the years of publication?

Method

Research Design

In the study, qualitative research design was employed in the descriptive survey model and the data were analyzed through document analysis. In document analysis, which is defined as a systematic process in which both printed and electronic materials are examined and evaluated, different documents that constitute the data set are collected, examined and questioned and the analysis process is carried out (Özkan, 2022). In the analysis process, in addition to personal documents, print media sources, periodicals, magazines, journals, newspapers, magazines and books are also utilized (Yıldırım & Şimşek, 2011).

Participants

Criterion sampling method, which is one of the purposeful sampling methods, was utilized in the selection of the journals to be included in the study. As a criterion, starting from 2016, the year the SDG universal call for action was published, 72 issues, including the December 2021 issue in which the project proposal was submitted, were included in the scope of the research. Activities and games in the journal were not included in the analysis.

Data collection

In this study, all issues (72 issues) of Bilim Çocuk magazines published by TÜBİTAK Popular Science Publications between 2016-2021 were examined and analyzed as data collection tools. The control chart prepared by the researchers to determine the texts containing implicit or direct information sharing regarding the SDG items was submitted to the opinion of two faculty members who are experts in their fields and utilized in the examination of the magazine after the necessary arrangements. The examination of the documents obtained for the Bilim Çocuk magazine examined within the scope of the research in terms of sustainable development goals was carried out in a three-stage process, and in the first stage, all issues of the magazine published between 2016-2021 were obtained. Considering the possibility of not having internet access, it was preferred to obtain all issues of the magazine in printed form, but since the printed issues of the previous years could not be obtained, access was provided via e-journal. In the second stage, the distribution of text types, the distribution of these texts according to the frequency of including sustainable development goals and the change in this frequency according to the years of publication were examined, and in the third stage, the data obtained were analyzed by document analysis method.

Data Analysis

The 72 issues of Bilim Çocuk magazine published in the years 2016-2021, which were determined by the criterion sampling method, were examined separately by the researcher and an academician who is an expert in the field twice at one-month intervals, and the types of texts in the magazines were determined according to the years. Then, the texts were examined one by one in the context of "Sustainable Development Goals and Indicators" on the official page of kureselamaclar.org and the SDGs that were considered to be related were listed, text titles and sample expressions were collected, and the data obtained according to the sub-problem titles were tabulated. In this process, Bilim Çocuk magazine was examined and the data collected were analyzed by document analysis.

Validity and reliability

For the validity and reliability of the analysis conducted by the researchers, the reliability formula determined by Miles and Huberman (1994) was employed and the agreement rate between the opinions was determined. In order to be reliable, the agreement obtained is required to be at least 70% (Yıldırım & Şimşek, 2011). In this direction, as a result of expert evaluations, the percentage of agreement in the analysis was calculated as 95.73%.

The data obtained were analyzed according to which text type, how often and how the sustainable development goals change according to the years of publication.

Findings and Discussions

The findings obtained within the scope of the aim of the research are presented in this section within the framework of the sub-objectives of the research.

Findings related to the first sub-problem

In the first sub-problem of the study, an answer was sought to the question " What is the distribution of text types that include SDGs in Bilim Çocuk magazine?". 2016 is the year in which 193 United Nations member countries published the universal call for action called Sustainable Development Goals (SDGs). For this reason, Bilim Çocuk magazines were analyzed starting from 2016. A total of 1876 texts were included in the 72 issues of Bilim Çocuk magazine. The majority of these texts, 92.59%, belong to the informative text type, while 7.40% belong to the narrative text type. No poetry texts were encountered in the magazines. Information on these values is presented in Table 1.

Tablo 1 Distribution of Text Types Including SDG in Bilim Çocuk Magazine

	Text Types					
	Informative		Narrative		Poetry	
Years	SDG	n	SDG	n	SDG	n
2016	24	285	-	37	-	-
2017	12	298	-	25	-	-
2018	21	270	-	17	-	-
2019	20	286	-	12	-	-
2020	13	296	-	23	-	-
2021	22	302	1	25	-	-
Total	112	1737	1	139	-	-

When Table 1 is examined, it is determined that the issues containing the most texts in terms of including SDGs belong to 2016. In the twelve issues published in 2016, there were a total of (n=322) texts and (n=24) of these texts featured SDGs. After 2016, SDGs were included in 327 texts (n=22) in 2021; 287 texts (n=21) in 2018; 298 texts (n=20) in 2019; and 319 texts (n=13) in 2020. The year 2017 was the year in which the number of texts that

included SDG was the lowest (n=12). As observed in Table 1, it is found that only in the cartoon series titled "Stories of a Scientist with Bagel and Cheese" in 2021 (July issue), the fourteenth SDG goal of "Life in Water" was included. The SDGs were not included in the narrative texts in any other issue. In the cartoon series "Stories of a Scientists with Bagel and Cheese", the life story of a scientist is narrated in each issue. In this episode, which includes the fourteenth purpose, Ruth Deborah Gates, who worked on coral reefs until the end of her life, attempted to comprehend the bleaching process in corals, and sought answers to the question of how to prevent this bleaching caused by the increase in sea water temperatures due to global climate change, was the scientist of this issue.

Findings related to the second sub-problem

In the second sub-problem of the study, an answer was sought to the question "How are the texts in Bilim Çocuk magazine distributed according to SDGs?". In the 72 issues of Bilim Çocuk magazine examined, there are a total of 1876 informative and narrative texts. Among these texts, 113 texts include sustainable development goals. Information on which goal among the seventeen goals is included in which text type is presented in Table 2.

Table 2 Distribution of Texts in Bilim Çocuk Magazine according to SDGs

Global Goals for Sustainable Development	Distribution of Texts according to SDGs		
	Informative	Narrative	General Total
1. Ending Poverty	-	-	-
2. Ending Hunger	-	-	-
3. Health and Quality of Life	-	-	-
4. Quality Education	3	-	3
5. Gender Equality	-	-	-
6. Clean Water and Sanitation	2	-	2
7. Accessible and Clean Energy	27	-	27
8. Decent Work and Economic Growth	1	-	1
9. Industry, Innovation and Infrastructure	28	-	28
10. Minimization of Inequalities	-	-	-
11. Sustainable Cities and Communities	6	-	6
12. Responsible Production and Consumption	31	-	31
13. Climate Action	20	-	20
14. Life in Water	12	1	13
15. Life on Land	8	-	8
16. Peace, Justice and Strong Institutions	-	-	-
17. Partnerships for Purposes	3	-	3
Total	141	1	142

When Table 2 is analyzed, among the seventeen global goals, SDG 12 "Responsible Production and Consumption" was mentioned most frequently (n=31). This is followed by SDG 9 "Industry, Innovation and Infrastructure" (n=28), SDG 7 "Accessible and Clean Energy" (n=27), SDG 13 "Climate Action" (n=20), SDG 14 "Life in Water" (n=13), SDG 15 "Life on Land" (n=8), SDG 11 "Sustainable Cities and Communities" (n=6), SDG 4 "Quality Education" (n= 3), SDG 17 "Partnerships for Purposes" (n=3), SDG 6 "Clean Water and Sanitation" (n= 2). It is observed that the least number of texts (n=1) is related to the "Decent Work and Economic Growth" goal. While most of the text types in these global goals (n= 141) are in the informative text type, only (n=1) of the texts related to the SDG 14 "Life in Water" goal are in the narrative text type. On the other hand, none of the texts included SDG 1 "End Poverty", SDG 2 "End Hunger", SDG 3 "Health and Quality of Life", SDG 5 "Gender Equality", SDG 10 "Reducing Inequalities", SDG 16 "Peace, Justice and Strong Institutions".

When the texts containing SDGs in Bilim Çocuk magazine were analyzed, it was determined that some texts included more than one purpose. As presented in Table 3, the text titled "Carbon Dioxide Converted into Stone" in the July 2016 issue contains information on both the SDG 7 and SDG 13. Information on these examples is provided in Table 3.

Table 3 Examples of Texts Including more than one SDG

Text Title	Included SDGs	Quote
Carbon Dioxide Converted into Stone	SDG 13: Climate Action SDG 7: Affordable and Clean Energy	"Scientists in Iceland have succeeded in turning carbon dioxide into stone at a low cost in a project called CarbFix. In the experiments, carbon dioxide and water were pumped into volcanic rock hundreds of meters underground. Scientists discovered that ninety-five percent of the pumped carbon dioxide reacted with minerals in the volcanic rocks and petrified in less than two years. Increasing carbon dioxide in the atmosphere is leading to climate change. By utilizing this method, it is believed that the amount of carbon dioxide released into the atmosphere can be reduced." (Bilim Çocuk, 2016, July, p. 5.)
Renewable Energy is Number One	SDG 7: Affordable and Clean Energy SDG 9: Industry, Innovation and Infrastructure	"The World Economic Forum recently published a report. According to this report, obtaining solar and wind energy is now as affordable as obtaining energy from fossil fuels. ... It is important that renewable energy sources are economical in order to prevent global warming in the future." (Bilim Çocuk, 2017, January, p.7.)
Old Clothes Can be Turned into Building Materials	SDG 9: Industry, Innovation and Infrastructure SDG 12: Responsible Production and Consumption	"When worn out or shrunken clothes are not recycled, they are thrown away. That's millions of tons of waste clothing around the world. Australian researchers have discovered a way to recycle this waste. After removing parts such as buttons and zippers, the garments were put through a shredder. A chemical substance was added to make the milled fibres of different types of fabrics stick together. This mixture was heated, compressed and shaped. Thus, low-flammable, water-resistant and robust panels that can be utilized as floor and wall coverings were obtained." (Bilim Çocuk, 2018, December, p. 4.)
Bioenergy is Produced from Wastewater	SDG 6: Clean Water and Sanitation	"Blue-green algae are considered a great source of bioenergy, but their cultivation requires a lot of water and nutrients. To solve this nutrient problem, the researchers attempted to grow blue-green algae in wastewater from a treatment plant. The blue-green algae utilized the phosphorus and nitrogen in

at the Treatment Facility	SDG 7: Affordable and Clean Energy	the wastewater as nutrients. Thus, the water was cleaned with less energy and bioenergy was obtained from the algae." (Bilim Çocuk, 2019, September, p. 6.)
Edible Packaging Made from Whey	SDG 9: Industry, Innovation and Infrastructure SDG 12: Responsible Production and Consumption	"Bioplastics are plastics derived from renewable biological resources such as vegetable oils or microorganisms. Altınkaya and her team developed a flexible, durable and edible bioplastic packaging by combining whey powder and corn protein. The product, which successfully passed the tests conducted by international organizations, was also protected by a patent. Altınkaya stated that this new packaging is of great importance as an alternative to petroleum-based plastic products that harm nature." (Bilim Çocuk, 2020, February, p. 5.)
Next Generation Technology Hybrid Cars	SDG 7: Affordable and Clean Energy SDG 11: Sustainable Cities and Communities	"Hybrid cars have the technology to overcome many of these problems because they reduce the use of fossil fuels thanks to their electric systems. These systems use electricity when needed and fossil fuels when needed. In addition to using energy more efficiently, hybrid cars also generate their own electricity. They therefore operate at a much lower cost than fossil fuel-only cars. Of course, since fossil fuel consumption is reduced in these cars, harmful gases emitted from the exhaust are also reduced." (Bilim Çocuk, 2021, February, p. 13.)

Two visuals of the texts in Bilim Çocuk magazine that include SDGs, examples of which are presented in Table 3, are provided in Figure 1 and Figure 2 below.

Figure 1 Bioenergy is Produced from Wastewater at the Treatment Facility (Bilim Çocuk, September 2019, p.6)

Figure 2 Edible Packaging Made from Whey (Bilim Çocuk, February 2020, p.5)

Findings related to the third sub-problem

In the third sub-problem of the study, an answer was sought for the question "Does the frequency of the texts in Bilim Çocuk magazine to include SDGs differ according to the years of publication?". The findings indicate that the frequency of the texts in the magazine to include sustainable development goals differs according to the years of publication and each goal. Information on this objective is presented in Table 4.

Table 4 The Relationship between the Frequency of SDG Inclusion in the Texts in Bilim Çocuk Magazine and Years of Publication

Global Goals for Sustainable Development	Number of Texts with SDGs in Journals by Years						
	2016	2017	2018	2019	2020	2021	General
1. End Poverty	-	-	-	-	-	-	-
2. End Hunger	-	-	-	-	-	-	-
3. Health and Quality of Life	-	-	-	-	-	-	-
4. Quality Education	1	-	-	2	-	-	3
5. Gender Equality	-	-	-	-	-	-	-
6. Clean Water and Sanitation	-	1	-	1	-	-	2
7. Accessible and Clean Energy	8	3	4	2	3	7	27
8. Decent Work and Economic Growth	-	-	1	-	-	-	1
9. Industry, Innovation and Infrastructure	5	4	4	1	7	7	28
10. Minimization of Inequalities	-	-	-	-	-	-	-
11. Sustainable Cities and Communities	-	-	1	2	2	1	6
12. Responsible Production and Consumption	3	4	11	5	6	2	31
13. Climate Action	4	2	1	3	1	9	20
14. Life in Water	2	3	3	2	-	3	13
15. Life on Land	4	-	-	3	1	-	8
16. Peace, Justice and Strong Institutions	-	-	-	-	-	-	-
17. Partnerships for Purposes	3	-	-	-	-	-	3
Total	30	17	25	21	20	29	142

When Table 4 is analyzed, it is observed that SDGs were included in a total of 24 texts in 2016, but a few of these texts were related to more than one global purpose. Therefore, the number of texts related to the goals in 2016 was determined as (n=30). In 2016, the most (n=8) texts related to SDG 7 “Accessible and Clean Energy", the least (n=1) texts related to SDG 4. “Quality Education", and a total of eight texts related to different goals.

In 2017, SDGs were included in a total of 12 texts, and a few of these texts were identified to be related to more than one purpose. Therefore, there were (n=17) texts related to the goals in 2017. In 2017, the most (n=4) texts related to SDG 9 "Industry, Innovation and Infrastructure" and (n=4) texts related to SDG 12 "Responsible Production and

Consumption", the least (n=1) text related to SDG 6 "Clean Water and Sanitation", and a total of six texts related to different goals.

In 2018, SDGs were included in a total of 21 texts, and a few of these texts were identified to be related to more than one purpose. Therefore, it was stated that there were (n=25) texts related to the goals in 2018. In 2018, most (n=11) texts related to SDG 12 "Responsible Production and Consumption", least (n=1) texts related to SDG 8 "Decent Work and Economic Growth", least (n=1) texts related to SDG 11 "Sustainable Cities and Communities", least (n=1) texts related to SDG 13 "Climate Action", and a total of seven texts related to different goals.

In 2019, SDGs were included in a total of 20 texts, and one of these texts was identified to be related to more than one purpose. Therefore, it was stated that there were (n=21) texts related to the purposes in 2019. In 2019, the most (n=5) texts related to SDG 12 "Responsible Production and Consumption", the least (n=1) texts related to SDG 6 "Clean Water and Sanitation" and the least (n=1) texts related to SDG 9 "Industry, Innovation and Infrastructure", in total nine texts related to different goals.

In 2020, SDGs were included in a total of 13 texts, and it was identified that a few of these texts were related to more than one purpose. Therefore, it was stated that there were (n=20) texts related to the goals in 2020. In 2020, the most (n=7) texts related to SDG 9 "Industry, Innovation and Infrastructure", the least (n=1) texts related to SDG 13 "Climate Action" and the least (n=1) texts related to SDG 15 "Life on Land", and a total of six texts related to different goals.

In 2021, SDGs were included in a total of 23 texts, and it was identified that a few of these texts were related to more than one purpose. Therefore, it was stated that there were (n=29) texts related to the goals in 2021. In 2021, the most (n=9) texts related to the SDG 13 "Climate Action" purpose, the least (n=1) texts related to the SDG 11 "Sustainable Cities and Communities" purpose, and a total of six texts related to different purposes were included. Figure 1 presents a graph illustrating the relationship between the frequency of SDG-related texts in Bilim Çocuk magazine and the years of publication.

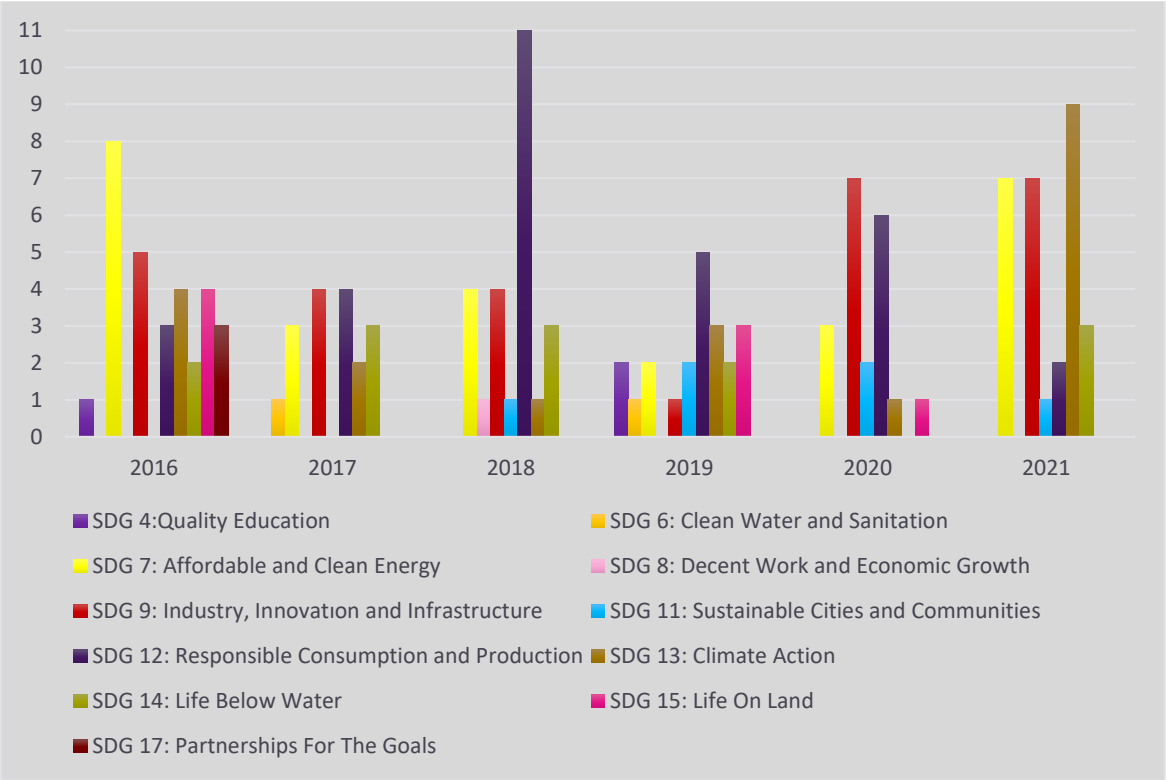

Figure 3 The Relationship between the Frequency of SDG Inclusion in Texts and Years of Publication

The ratio of the texts related to sustainable development goals in Bilim Çocuk magazine to the total number of texts in the magazine was compared according to the years of publication, from 2016, the year in which the universal call for action on sustainable development goals was published, to December 2021, including the December 2021 issue. This information is presented in Table 5.

Table 5 Ratio of the Number of SDG-Related Texts to the Total Number of Texts in the Journal by Year of Publication

Year of publication	Number of SDG-related texts	Total number of texts in the journal	%
2016	30	322	9.31
2017	12	323	3.71
2018	21	287	7.31
2019	20	298	6.71
2020	13	319	4.07
2021	23	327	7.03
Total	113	1876	6.02

When the ratio of the number of SDG-related texts to the total number of texts in the journal is analyzed according to the distribution of the years; there are a total of (n= 322) texts

in the journal published in 2016, and 9.31% (n= 30) of these texts are SDG-related texts. In the journal published in 2017, there were a total of (n= 323) texts, and 3.71% (n= 12) of these texts were SDG texts. In the journal published in 2018, there were a total of (n= 287) texts, and 7.31% (n= 21) of these texts were SDG texts. In the journal published in 2019, there were a total of (n= 298) texts, and 6.71% (n= 20) of these texts were SDG texts. In the journal published in 2020, there were a total of (n= 319) texts, and 4.07% (n= 13) of these texts were SDG texts. The journal published in 2021 contains a total of (n= 327) texts, 7.03% (n= 23) of which are SDG texts. In general, 72 issues published in six years contain a total of (n= 1876) texts, and 6.02% (n= 113) of these texts are SDG texts.

Conclusions and Suggestions

The American Association of School Libraries (2018) discussed the need for reform in schools and education in the 21st century, with teachers and educational researchers as well as policy makers considering both the social and economic necessities of students and society (Ananiadoui & Claro, 2009). In the "Key Competences for Lifelong Learning-A European Reference Framework" published by the European Union, eight key competencies for lifelong learning are identified. These competencies are literacy competence, multilingual competence, mathematical competence and competence in science, technology and engineering, digital competence, personal, social and learning to learn competence, citizenship competence, entrepreneurship competence, cultural awareness and expression competence. Core competences are developed throughout life through formal, non-formal and informal learning in different settings, including family, school, workplace and other communities (European Union, 2007). In addition to the family and immediate environment, these core competencies are developed in schools, which are the formal education institutions where children spend most of their time. Therefore, reading materials are also utilized in schools to support these competencies. One of these materials, Bilim Çocuk magazine, which is one of the children's literature products and constitutes the subject of this study, is valuable both in terms of the development of the 8 basic competencies mentioned above and because it deals with the issue of sustainability, a universal problem that is on the agenda of the world.

When the literature on the subject is examined, it is concluded that teachers do not have sufficient knowledge about the economic elements related to sustainable development issues (Borg et al., 2014), generally have a shallow and oversimplified understanding of sustainability (Birdsall, 2014) or have misconceptions about the concept of sustainable

development (Spiropoulou et al., 2007). Therefore, it is evident that when teaching sustainable development goals, they fail to assist students to develop a holistic view of the concept (Borg et al., 2014).

Borg et al. (2012; 2014) and Boeve-de Pauw and Van Petegem (2011) reported that there is a lack of good practices to inspire students and a lack of expertise on sustainable development. Therefore, the children's magazine examined in this study is an educational material that teachers can benefit from even if they lack expertise in sustainable development. However, it is also suggested that it may be appropriate to include diversity in the text types in the magazine at the point of bringing children together with universal knowledge. Because children like to read different types of texts. The cartoon series in the magazine are texts that attract children's attention and are suitable for their age and learning levels, both in terms of fiction and in terms of presenting sections from the life stories of scientists. However, there are very few of them in the magazine. It is believed that texts in this genre, which can attract the attention of children who like to read works in the cartoon series genre, can appeal to a larger number of child readers when they are associated with the SDGs.

The Global Goals for Sustainable Development are based on seventeen goals. It is observed that Bilim Çocuk magazine contains texts related to eleven of these goals. It is believed that this magazine, which is widely followed by children, adults and educators, is an exemplary publication in terms of raising awareness about the SDGs, raising sensitivity, and motivating individuals and institutions to take action. For this reason, it is recommended that other goals that are not included should be included in subsequent issues. When analyzed in terms of years, the SDGs were officially adopted with the call for action signed in 2016. From 2016 onwards, it was predicted before the study that the texts including SDGs would continue to increase in each issue. However, the findings and the predicted results were different. While in 2016, the number of texts that included the SDGs was (n= 30), this number first declined in the following years, but showed an upward trend again in 2021 (n= 29). Therefore, the increase in the number of texts that include SDGs in the magazine in the following issues brings with it the idea that Bilim Çocuk magazine will be an exemplary publication for raising awareness on this issue.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

We declare that there is no material conflict of interest between any institution, organization, person and authors during the preparation of the research, collection and evaluation of data, interpretation of the results and finalization of the writing process of the article.

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CRediT author statement

The researchers contributed equally to the study.

Research involving Human Participants and/or Animals

In the writing of the study titled "In the Light of Current Problems in Education: TÜBİTAK Science Child Magazine and Building a Sustainable Future", scientific rules, citation and ethical rules were adhered to, no changes were carried out on the data obtained from the magazines examined, and the necessary permission was obtained by TÜBİTAK Popular Science Publications to examine all the issues of the magazine between 2016-2021. The research data were published as an abstract in "IPTES 2022, 20th International Primary Teacher Education Symposium". The research results were not submitted to another academic publication environment for evaluation in an expanded and comprehensive manner. Ethical permission was obtained from Balikesir University Social Sciences and Humanities Ethics Commission (Date: 07.07.2022, Number: 19928322/605.01/159185).

Eğitimde Güncel Sorunların Aydınlığında: TÜBİTAK Bilim Çocuk Dergisi ve Sürdürülebilir Geleceğin İnşası**

Özet:

Araştırma, eğitimin güncel sorunlarından biri olan 21. yüzyıl becerilerinin geliştirilmesine destek sağladığı ve dünyanın ortak gündemi olan sürdürülebilir kalkınma amaçlarına yer verdiği ön görülen, çocukların eğitim sürecinde kullanabilecekleri, bilimsel anlamda gelişimlerine katkı sağlamayı amaçlayan Bilim Çocuk dergisindeki metinlerin, sürdürülebilir kalkınma amaçlarını ne ölçüde desteklediğini belirlemektir. Nitel araştırma deseninin kullanıldığı bu araştırmada veriler doküman incelemesi yolu ile toplanmış, elde edilen veriler, yüzde ve frekans ile tablolaştırılarak yorumlanmıştır. Araştırmada kullanılacak dergilerin seçiminde amaçlı örnekleme yöntemlerinden ölçüt örnekleme yöntemiyle belirlenen, 2016-2021 yıllarında yayımlanan 72 sayısı incelenmiştir. Araştırma bulgularına göre Bilim Çocuk dergisindeki metinlerin %92,59'unun bilgilendirici metin türüne, %7,40'ının hikâye edici metin türüne ait olduğu, dergideki metinlerin; on yedi küresel amaç arasından en çok (n=31) "12. Sorumlu Üretim ve Tüketim", en az (n=1) "8. İnsana Yakışır İş ve Ekonomik Büyüme" amacıyla ilişkili olduğu belirlenmiştir. Dergideki metin türlerinde çeşitliliğe yer verilmesi, sürdürülebilir kalkınma amaçları konusunda farkındalık oluşturması ve kişi ile kurumları harekete geçirmesi bağlamında henüz yer verilmeyen diğer amaçlara da yer verilmesi önerilmektedir.

Anahtar kelimeler: Sürdürülebilirlik, sürdürülebilir kalkınma amaçları, çocuk edebiyatı**,** 21. yüzyıl becerileri.

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Research Article

The Impact of Khan Academy Learning Platform on Mathematics Achievement in Primary School Fourth Grade Students

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Abstract – This study aims to examine the effect of the Khan Academy learning platform on students' achievement in mathematics lessons. In the study, the difference between the achievement levels of the experimental and control groups was tested using a pre-test post-test control group design. The study group consists of primary school fourth grade students attending the support and training course. The study was conducted with a total of 60 students. The students in the experimental group were provided with mathematics course contents via the Khan Academy learning platform, and teaching was carried out using these contents. The students in the control group were taught mathematics with the Education Information Network (EBA). Firstly, a pre-test was applied to both groups, and the achievement levels of the students were recorded. Then, the Khan Academy learning platform was introduced to the students in the experimental group, and this platform was used in mathematics lessons. The students in the control group were introduced to EBA, and this platform was used in mathematics lessons. After a certain period of time, the post-test was applied to both groups, and the achievement levels of the students were measured again. The difference between the achievement levels of the experimental and control groups was statistically analyzed using the data obtained. As a result of this analysis, it was concluded that the Khan Academy learning platform had a greater effect on students' achievement in mathematics.

Key words: Khan Academy, Education Information Network (EBA), primary school, mathematics, achievement.

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Introduction

Mathematics education is vital to the cognitive development of pupils and is considered an essential skill. Enhancing students' mathematical abilities and achieving success in mathematics classes are crucial factors that not only impact their academic achievements but

also influence their future career choices. However, mathematics instruction presents a challenge as it requires considering the differences among students, such as their learning pace, prior knowledge levels, and learning styles (Güler & Basım, 2016; Kaya et al., 2013; Ulus et al., 2015).

In recent years, technological advancements have provided new opportunities in mathematics education. Online learning platforms like Khan Academy, in particular, have revolutionized mathematics learning. Khan Academy is known as a platform that provides millions of students worldwide with free access to a comprehensive mathematics learning experience. The platform offers interactive lessons, practice questions, personalized feedback, and progress tracking, providing students with a personalized and interactive learning experience (Altun, 2006; DiSalvo & Morrison, 2013; Morrison & DiSalvo, 2014).

In this context, it is important to examine the impact of the Khan Academy learning platform on enhancing mathematics achievement and enriching the learning experience of fourth-grade elementary school students. Research in the literature demonstrates the positive effects of online learning platforms on mathematics achievement. These platforms assist students in improving their mathematical skills while enabling teachers to track individual learning progress and provide tailored support to students (Çoruk & Çakır, 2017; Tabuk, 2019).

Online platforms like Khan Academy, which allow students to experience self-directed learning, play a significant role in terms of accessibility to mathematics education and student motivation (Sürmeli & Ünver, 2017). The significance of this study lies in evaluating the use of Khan Academy as an effective instructional strategy to enhance the mathematics achievement of fourth-grade students. By filling gaps in the literature and expanding existing knowledge, this research can make a valuable contribution to enriching and improving pedagogical practices focused on mathematics education. Additionally, this study can provide teachers and education policymakers with a better understanding of the effects and potential impacts of online learning platforms in mathematics instruction.

An important contribution of this study is the evidence-based examination of the impact of Khan Academy in mathematics classes. This research will provide a stronger understanding of the effectiveness of Khan Academy based on existing scientific evidence, assisting in making strategic decisions regarding mathematics education. Specifically, by examining its

impact on fourth-grade students, it can play a significant role in shaping policies and practices focusing on early-stage mathematics instruction.

Furthermore, this study enhances the prevalence of online learning platforms in mathematics education (Gürsul, 2008), increasing the potential for improving students' mathematical skills. Encouraging the use of technological innovations in mathematics education can help students strengthen their mathematical thinking skills and establish a solid foundation for their future achievements.

In conclusion, evaluating the use of online learning platforms such as Khan Academy to enhance the mathematics achievement and learning experience of fourth-grade students is of great importance. This study can reinforce pedagogical strategies by exploring innovative approaches in mathematics education to support students' mathematical skills and prepare them for a successful future.

Khan Academy

The use of technology in mathematics education has gained significant importance in recent years. In particular, online learning platforms have become effective tools for enhancing mathematical skills (Dickinson, 2016; Kaya et al., 2013; Kelly, 2018; Ulus et al., 2015). One of these platforms, Khan Academy, provides extensive usage and interaction in mathematics instruction.

Khan Academy's personalized learning experience allows students to develop their mathematical skills according to their individual learning needs. Studies have demonstrated the positive effects of personalized learning experience on student achievement and mathematical skills. Khan Academy offers students the opportunity to receive instant feedback and track their progress. Research in the literature has shown that feedback and progress tracking enhance student motivation and support mathematical achievement (da Silva & Coutinho, 2020; Kelly & Rutherford, 2017; Lawless et al., 2013).

As an online platform, Khan Academy provides broad access to mathematics education. Therefore, it offers a significant advantage for students living in economically or geographically restricted areas. Numerous studies have highlighted the positive effects of online learning platforms on mathematics learning and achievement with the proliferation of online learning platforms. Platforms like Khan Academy serve as indicators of the future use of educational technologies. Advancements in technology and digital resources present new opportunities in mathematics instruction. Such online platforms can be used as an additional

resource for students to enhance their mathematical skills, alongside traditional classroom environments. Research shows that technology-based mathematics instruction improves student achievement and contributes to the development of mathematical skills (Kelly & Rutherford, 2017; Lawless et al., 2013).

The learning materials offered by Khan Academy contain topics, examples, and practice questions presented in a clear and understandable manner. These materials provide students with a learning experience supported by visual and auditory elements to better understand mathematical concepts. It is noted that the use of this platform enables students to improve their understanding of mathematical topics, enhance problem-solving skills, and increase their confidence in mathematics (Light & Pierson, 2014; Otobelli et al., 2018).

In conclusion, online learning platforms such as Khan Academy have positive effects on mathematics learning and achievement. These platforms enable students to experience self-directed, personalized, and technology-based learning. Due to their accessibility and widespread availability, these platforms can play an even more significant role in mathematics education in the future. Therefore, examining the impact of Khan Academy on mathematics instruction based on the literature is of great importance for educators to identify best practices in mathematics teaching and develop technology-based learning approaches (da Silva & Coutinho, 2020; Lawless et al., 2013; Otobelli et al., 2018).

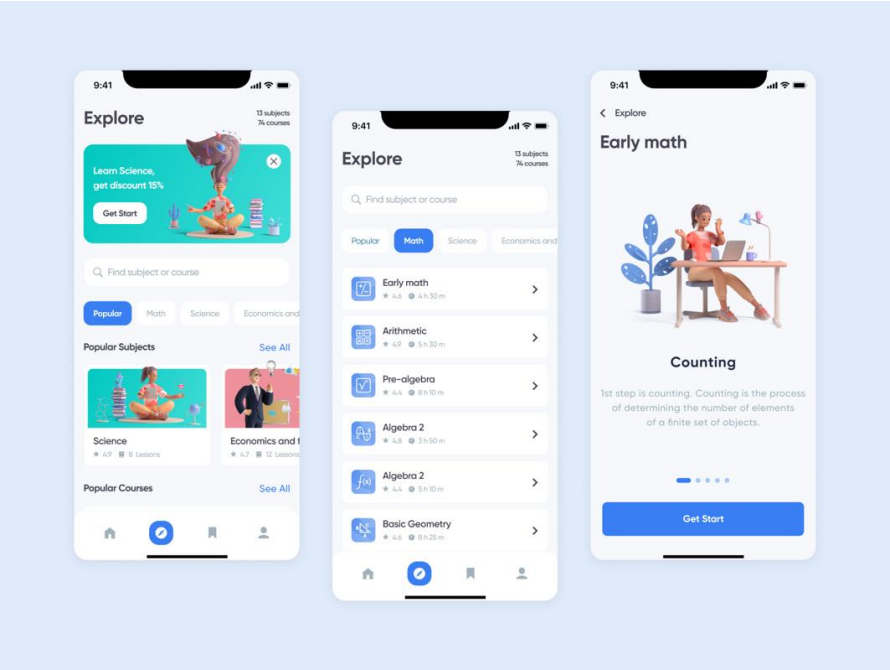

Figure 1 Khan Academy mathematical interface

Education Informatics Network (EBA- Eğitim Bilişim Ağı)

Education Informatics Network (EBA) is a digital platform provided free of charge to all students and teachers in Turkey. The platform is accessible through a website and mobile applications. EBA offers a rich content archive for students at every level. This content includes lecture notes, interactive teaching materials, video lessons, interactive games, and more. Additionally, teachers can assign homework, conduct exams, and track student progress through EBA. The Education Informatics Network (EBA) is a project aimed at improving the quality of the educational process and ensuring equal opportunities in education in Turkey. By providing teachers, students, and parents with rich content, educational materials, and digital tools, EBA aims to make the educational process more interactive and accessible (Atasoy & Nayir, 2019; Coşkunserçe & İşçitürk, 2019; Kılcan & Üçarkuş, 2018).

EBA stands out as a platform frequently used by teachers in Mathematics classes. It hosts mathematics content for almost every level. Research has been conducted on mathematics education and EBA in Turkey (Atasoy & Nayir, 2019; Bertiz, 2017).

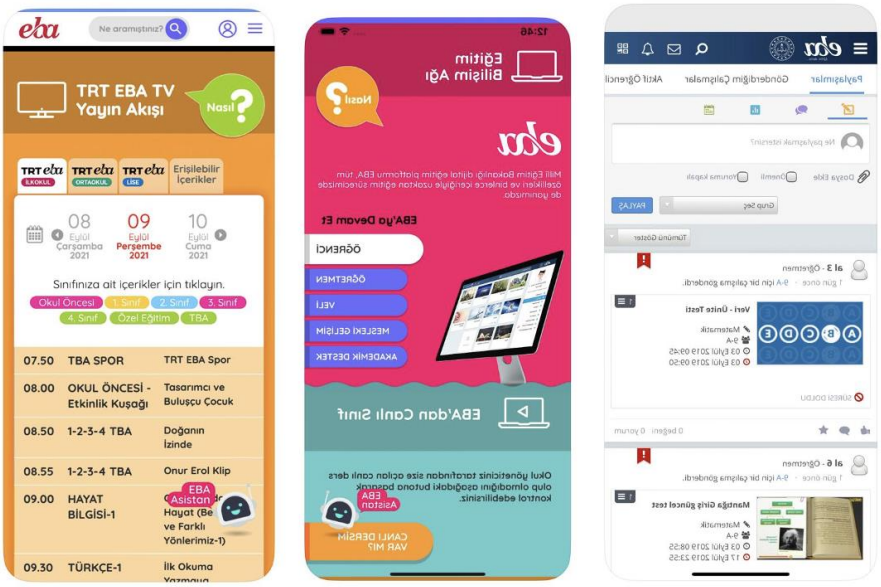

Figure 2 EBA interface

Mathematics Curriculum and Technology

The Primary School Mathematics 2018 Curriculum of the Ministry of National Education in Turkey emphasizes the importance of using technology in mathematics education. Among the objectives of the curriculum are to enhance students' mathematical thinking skills, enable them to use mathematical concepts in concrete and abstract situations,

and enable them to effectively use technology in mathematics instruction. One of the general principles of the curriculum is to encourage students to learn effectively by using technology in mathematics education. The curriculum recommends the use of technological tools that allow students to explore mathematical concepts, visualize them, and engage in interactive mathematical experiences. These tools help students enhance their mathematical thinking skills, concretize abstract concepts, and understand mathematical connections (Ministry of National Education [MoNE], 2018).

Furthermore, diversifying the activities and providing students with different learning experiences within the curriculum is also crucial. The use of technology is considered a means to achieve this diversity and to stimulate students' interest in mathematics education. The aim is to strengthen students' mathematical thinking skills, improve their problem-solving abilities, and enable them to use mathematical concepts meaningfully (Bütüner, 2006; Ersoy, 2006; MoNE, 2018).

The emphasis on the importance of technology use in the 2018 Primary School Mathematics Curriculum of the Republic of Turkey Ministry of National Education indicates our recognition of the potential and impact of technology in mathematics instruction. Therefore, exploring and evaluating the use of technology-based mathematics learning tools is an important step for educators to plan and implement mathematics instruction in line with the curriculum's objectives (Ersoy, 2006). Online learning platforms such as Khan Academy can also be considered effective resources that contribute to students' mathematics learning in this context.

Since the 2000s, the field of distance education, especially internet technology and digital space, has gained full function. Educational opportunities have been offered to millions of people, including domestic and international education (Gürer et al., 2016). However, with the effect of the pandemic in Turkey, education has developed with the help of distance education platforms. EBA is at the forefront of these platforms. EBA, which is used in various courses, has become a widespread and effective teaching platform (Bakırcı et al., 2021; Yangil & Özdoğan, 2022). However, interest in international non-formal education platforms has also increased considerably. Khan Academy (Noer, 2012), which has become the world's largest school with 10 million students in a short time, is now used as a platform to support learning in many countries around the world. Turkey is one of these countries. Numerous studies on the use of Khan Academy in Turkey, especially in the field of mathematics (San &

Aykaç, 2020), can be seen as an indicator of this use. Comparing the impact of these learning platforms on learning can be useful from various perspectives, especially in the context of mathematics education. It is thought that comparing digital platforms, which have an important place in mathematics education, will contribute to teachers and parents in practice, students in learning activities, and practitioners in creating an effective curriculum.

Aim of the Study

The aim of the study is to determine the impact of the Khan Academy learning platform on the academic achievement in mathematics of fourth grade primary school students. In line with this objective, the following research questions have been addressed:

Research Questions: What is the effect of the Khan Academy learning platform on the academic achievement of fourth grade primary school students taking mathematics lessons?

1. Is there a statistically significant difference between the pre-test scores of the experimental and control groups?

2. Has the use of Khan Academy in the experimental group resulted in a significant difference in favor of the post-test?

3. Have the interventions in the control group resulted in a significant difference in favor of the post-test?

4. Has the use of Khan Academy in the experimental group affected student achievement compared to the interventions in the control group?

By examining the impact of the Khan Academy learning platform on the academic achievement in mathematics of fourth grade primary school students, this research aims to make a significant contribution to improving students' mathematical skills and enhancing their learning experiences. One of the distinguishing factors of this research is the absence of a comparison with traditional methods (Akbaş, 2019; Ferman et al., 2019; Kelly & Rutherford, 2017).

Method

This study employs an experimental design aiming to determine the impact of the Khan Academy learning platform on the academic achievement in mathematics of fourth grade primary school students. The quasi-experimental design is an ideal method to determine the impact of the independent variable, the Khan Academy learning platform, on the dependent variable, students' mathematics achievement. This design allows for comparison between two

groups to ascertain their effectiveness (Büyüköztürk, 2007). The experimental group consists of students utilizing the Khan Academy learning platform, while the control group comprises students who receive instruction using the Educational Informatics Network (EBA). During the research process, both groups undergo a pre-test. Subsequently, the experimental group receives mathematics instruction through the Khan Academy learning platform, while the control group is taught using EBA. Afterward, both groups are administered a post-test, and the collected data are compared. In this manner, the impact of Khan Academy on mathematics achievement is statistically determined. This experimental design facilitates the data collection and inference process in a controlled environment aligned with the research objective. The pre-test post-test control group design aims to contribute to educational practices by enabling a clearer understanding of the effect on mathematics achievement.

Table 1 Research Design: The Impact of Khan Academy on Mathematics Achievement

Groups	Pre-test	Experiment Process	Post-test
Experimental	Attainment test	The carried-out exercises and courses in the Khan Academy Platform	Attainment test
Control	Attainment test	The carried-out exercises and courses by EBA	Attainment test

The procedures implemented in the experimental group of the study involved students engaging in mathematics exercises and lessons on the Khan Academy platform. In the control group, instructional activities utilizing the Educational Informatics Network (EBA) were used. Pre-test and post-test assessments were conducted to measure mathematics achievement. At the beginning of the research, students were evaluated with a pre-test, and then relevant procedures were applied according to the experimental and control groups. Finally, students in both groups were assessed with a post-test. A total of 18 hours of instructional time were allocated for both groups throughout the implementation period.

Participants

The research was conducted with fourth grade students attending a remedial and enrichment course at a primary school located in the Seyhan district of Adana province during the 2022–2023 academic year. The selection of the school and the study group took into consideration the voluntary participation of school administrators and classroom teachers. One of the two branches in the school was designated as the experimental group, while the other branch served as the control group. Descriptive statistics regarding the students in the experimental and control groups are provided in Table 2.

Table 2 Number and Percentages of Students in the Experimental and Control Groups

Groups	Gender				Total
	Female		Male		
	frequency	%	frequency	%	
Experimental group	15	50	15	50	30
Control group	14	47	16	53	30

In a quasi-experimental design, the "matched sampling" method can be used as the most reliable and least discrepant sample selection method for the experimental and control groups. Matched sampling involves pairing participants in the experimental and control groups based on specific characteristics to minimize the initial differences observed between the groups. In this method, matching is done based on similar demographic characteristics, pre-measured variables, or other important factors between the experimental and control groups (Büyüköztürk et al., 2012). In my study, to examine the impact of the Khan Academy learning platform on mathematics achievement among fourth grade primary school students, I could have matched students from each pre-determined branch as experimental and control groups. Considering factors such as students' gender, age, and mathematics achievement level, I selected a similar control group student for each experimental group student. In this way, I obtained a more homogeneous and balanced sample that included students with similar characteristics between the experimental and control groups. This will result in more reliable findings and allow for a more accurate attribution of the differences between the experimental and control groups to the effect of Khan Academy.

This study aims to investigate the impact of the Khan Academy learning platform on mathematics education among fourth grade elementary school students. This age group is in the developmental stage of fundamental mathematical skills. Additionally, their familiarity with technology and similar characteristics make them suitable for better matching experimental and control groups. Given that mathematics education is a fundamental component, enhancing the achievement of students in this age group can positively contribute to their future learning. Lastly, due to their inclination towards using online learning platforms, students in this age group can be considered a suitable choice in line with the research objectives.

Material

The data for the study were obtained from the "Achievement Test" results related to the "Data Collection and Evaluation" unit of the students. This test was administered to both groups of students, and their achievement scores were recorded. The achievement test was used to measure the level of understanding of the topics covered in the relevant unit.

The preparation of the "Achievement Test," which is where the quantitative data of the study were collected, was conducted through the following procedures: Firstly, the learning outcomes of the "Data Collection and Evaluation" unit, which the study focused on, were determined. These learning outcomes were based on the relevant unit in the Ministry of Education's mathematics curriculum. Upon determining the learning outcomes, a specification table encompassing the content and outcomes was created. The created specification table was presented to experts for their opinions, and necessary adjustments were made before proceeding to the question-writing process. In accordance with the learning outcomes and the number of questions specified in the specification table, a total of 35 items were created. This specification table and the developed items were presented to an assessment expert, a mathematics teacher, and a classroom teacher for their opinions. Based on the expert opinions, aspects such as technical suitability, language use, and content validity of the questions were evaluated, and it was decided to include 25 items in the pilot test. The pilot test was administered to 245 fifth grade students who had covered the same curriculum in the previous year. The results of the pilot test were analyzed for validity and reliability, and the number of questions was determined to be 25, ensuring content validity. The internal consistency coefficient of the pilot test was calculated at 0.78, and the final test's internal consistency coefficient was determined at 0.82. In the study, a final test consisting of 20 items was used as the pre-test and post-test.

Data Collection

The data were collected by the researcher from the experimental and control groups. Prior to the experimental procedures, the achievement test was administered to both the experimental and control groups by the researcher. At the end of the study, the achievement test was administered to both groups.

Data Analyses

In the initial phase of this study, the descriptive statistics of the quantitative data obtained from the "Achievement Test" related to the "Data Collection and Evaluation"

learning domain in the fourth grade mathematics course were calculated. These statistics include measures such as arithmetic means and standard deviations. Before proceeding with data analysis, it was examined whether the collected data were within predetermined boundaries and whether they contained errors; subsequent procedures were conducted thereafter. In the analyses, students' demographic characteristics and groups were considered as independent variables, whereas achievement test scores were treated as the dependent variable. The students' mean and standard deviations of pre-test, post-test, and retention test scores were computed. The normal distribution of pre-test, post-test, and retention test scores of both the experimental and control groups was investigated using the Kolmogorov-Smirnov test. In comparing the obtained mean values, the "t-test" method was used for both related and unrelated samples. The dependent (related) t-test was used for comparisons within the experimental and control groups, while the independent (unrelated) t-test was used for comparisons between the groups.

Experimental Implementation Process

Within the scope of this study, the aim was to investigate the impact of the Khan Academy learning platform on the mathematics achievement of fourth-grade primary school students. The study employed a pre-test post-test control group design to assess the difference in achievement levels between experimental and control groups. The experimental group consisted of a total of 60 students attending remedial and enrichment courses at the fourth-grade level. Students in the experimental group were provided with mathematics course content through the Khan Academy learning platform, and instruction was conducted using this content. Students in the control group, on the other hand, received mathematics instruction through the Education Informatics Network (EBA). Initially, a pre-test was administered to both groups, and their achievement levels were recorded. Subsequently, students in the experimental group were introduced to the Khan Academy learning platform, and they were guided to use this platform for their mathematics lessons. Meanwhile, students in the control group were introduced to EBA and used that platform for their lessons. At the end of the designated period, a post-test was administered to both groups, and students' achievement levels were measured once again. The collected data were used for the statistical analysis of the difference in achievement levels between the experimental and control groups.

Findings

In this research, the independent "t-test" was employed to compare the scores obtained from the achievement test in order to answer the research question, "Is there a statistically

significant difference between the pre-test scores of the experimental and control groups?" The results of the analysis are presented in Table 3.

Table 3 Descriptive Statistics of the Achievement Test for the Experimental and Control Groups

Tests	(n)	Pre-test		Post-test		Score (post-pre)	
		x	Ss	x	Ss	x	Ss
Experimental	30	22.60	4.22	40.30	4.32	15.00	3.96
Control	30	21.10	3.63	28.20	4.91	7.72	3.82

The above table contains the achievement test data and relevant descriptive statistics for the experimental and control groups in the "Data Collection and Evaluation" unit of the fourth grade mathematics class. The number of students in each group was determined to be 30. In the experimental group, the mean of the pre-test scores is 22.60 with a standard deviation of 4.22. The mean of the post-test scores is 40.30 with a standard deviation of 4.32. In the control group, the mean of the pre-test scores is 21.10 with a standard deviation of 3.63. The mean of the post-test scores is 28.20 with a standard deviation of 4.91. The mean of the gain test scores is 15.00 with a standard deviation of 3.96 for the experimental group. The mean of the gain test scores is 7.72 with a standard deviation of 3.82 for the control group.

Table 4 Comparison of Pre-Test Scores between the Experimental and Control Groups

Groups	n	x	s	sd	t	p
Experimental	30	22.60	4.22	58	0.763	0.462
Control	30	21.10	3.63			

The above table presents the comparison of pre-test scores between the experimental and control groups. In the experimental group, the mean of the pre-test scores was determined to be 22.60 with a standard deviation of 4.22. In the control group, the mean of the pre-test scores is reported as 21.10 with a standard deviation of 3.63. The t-test results indicate that with a p-value of 0.462, there is no statistically significant difference at the 0.05 level. It can be concluded that there is no significant difference between the groups in terms of the scores obtained from the achievement test.

Table 5 Comparison of Pre-Test and Post-Test Scores in the Experimental Group

Groups	n	x	s	sd	t	p
Experimental	30	22.60	4.22	29	7.611	0.000
Control	30	40.30	4.32			

As observed in Table 5, the mathematics activities conducted with Khan Academy in the experimental group have significantly improved students' achievements (t = 7.611, p = 0.000). This result demonstrates a statistically significant difference between the pre-test and post-test scores of students in the experimental group. Thus, it indicates that the mathematics activities conducted with Khan Academy are effective in enhancing students' academic performance. Therefore, the answer to the question "Did the mathematics activities conducted with Khan Academy in the experimental group result in a significant difference in favor of the post-test?" is affirmative. Students in the experimental group have obtained higher scores in the post-test as a result of the influence of the mathematics activities conducted with Khan Academy. This finding highlights that mathematics activities with Khan Academy are an effective method for improving students' achievements.

Table 6 Comparison of Pre-Test and Post-Test Scores in the Control Group

Groups	n	x	s	sd	t	p
Experimental	30	21.10	3.63	29	3.938	0.000
Control	30	28.20	4.91			

As shown in Table 6, it has been determined that the activities conducted using the EBA platform in the control group have significantly increased students' achievements (t = 3.938, p = 0.000). In other words, the activities carried out in the control group have significantly improved students' scores in favor of the post-test at the 0.05 level.

The fourth sub-question of the research is formulated as "Did the mathematics activities conducted with Khan Academy in the experimental group influence student achievement compared to the activities conducted in the control group?" In this study, an independent (unrelated) t-test was used to compare the gain scores of the experimental and control groups, and the findings are presented in Table 7.

Table 7 Comparison of Gain Scores between the Experimental and Control Groups

Groups	n	x	s	sd	t	p
Experimental	30	15.00	3.96	58	3.715	0.001
Control	30	7.72	3.82			

Table 7 reveals that at the end of the study, the experimental group showed an average increase of 15.00, while the control group showed an average increase of 7.72. By comparing these results, it has been determined that the mathematics activities conducted with Khan

Academy in the experimental group are more effective in improving students' achievements compared to the activities in the control group. The difference between the two groups is statistically significant in favor of the experimental group at the 0.05 level. It has been observed that the mathematics activities with Khan Academy particularly enhance students' achievements in the "Data Collection and Evaluation" unit of the mathematics course.

Result, Discussion and Suggestions

The t-test results indicated that there was no statistically significant difference between the pre-test scores of the experimental and control groups. Upon examining the pre- and post-test scores of the experimental group, it was found that the mathematics activities conducted with Khan Academy significantly increased students' achievement levels. The students in the experimental group achieved higher scores in the post-test as a result of their engagement with Khan Academy activities. Likewise, upon analyzing the pre- and post-test scores of the control group, it was determined that the activities utilizing EBA educational platforms significantly enhanced students' achievement levels. The students in the control group obtained higher scores in the post-test due to different activities.

Upon examining the achievement scores of the experimental and control groups, it was determined that the experimental group's achievement test scores were significantly higher than those of the control group. The mathematics activities conducted with Khan Academy significantly enhanced students' accessibility to the "Data Collection and Evaluation" unit in the mathematics lesson.

Based on these findings, the research compared the achievement levels of the experimental and control groups, focusing on the "Data Collection and Evaluation" unit in the mathematics lesson. The results demonstrate that the mathematics activities conducted with Khan Academy significantly increased the achievements of students in the experimental group. This finding indicates that Khan Academy is an effective tool for mathematics learning and enhances students' success. The difference in scores between the pre-test and post-test was higher for the students in the experimental group compared to the control group. In the control group, where EBA was utilized, it was observed that the activities contributed to student achievement. This indicates the impact of using EBA. However, the increase in achievement for the students in the experimental group was more pronounced compared to the control group. When examining the achievement test results, it was observed that students in the experimental group reached a higher level of accessibility as a result of the activities

conducted with Khan Academy. This indicates that Khan Academy facilitates students' access to the subject matter and enhances their understanding level.

In conclusion, this research demonstrates that mathematics activities conducted with Khan Academy enhance student achievement, particularly in relation to the topics covered in the "Data Collection and Evaluation" unit. These findings encourage educators and curriculum designers to further explore the use of digital resources in mathematics instruction and increase student success. When reviewing the literature, we can observe that the results of various studies support the findings of this research. However, many studies have compared an experimental group utilizing digital learning resources with a control group using traditional instructional methods (Akbaş, 2019; Ferman et al., 2019; Kelly & Rutherford, 2017). The results have shown that students in the experimental group achieve significantly higher mathematics scores than those in the control group. The results indicating that traditional teaching methods or tools have less impact compared to contemporary ones are not surprising. Therefore, it is believed that comparing current tools, platforms, methods, etc. (such as Khan Academy and EBA) in research studies would contribute more to the field.

Akbaş (2019) conducted a study investigating the impact of teaching fractions through animation-based content on student achievement using EBA (Educational Informatics Network) and traditional instructional methods. The results of the study showed that the experimental group (supported by EBA) significantly increased students' mathematics performance and motivation. Taking these findings into consideration, both studies demonstrate that digital learning platforms enhance student achievement. While this research indicates that the use of Khan Academy is more effective in improving mathematics performance, the second study suggests that EBA usage is more effective in developing fraction knowledge compared to traditional methods. In conclusion, both studies highlight the positive effects of digital learning platforms on student achievement. However, it is important to note that in our study, the EBA-supported group served as the control group, whereas in Akbaş (2019), it was the experimental group. Indirect inferences can be drawn from this distinction.

Furthermore, according to the findings of the study conducted by Özbey and Koparan (2020), EBA-supported education positively influenced the mathematics achievement and motivation of seventh grade students in the "Equality and Equation" topic. This research, along with the aforementioned study, demonstrates the positive effects of digital learning platforms on student achievement in various subjects and grade levels. These results suggest

that digital learning platforms can be effective tools in mathematics instruction and contribute to increased student success. However, considering the different characteristics of both studies and the variation in the platforms used, making direct comparisons may be challenging. Therefore, further research, incorporating different platforms as control groups, can help us better understand the effects of various digital platforms.

According to Zengin's (2017) research, the use of Khan Academy significantly increased mathematics achievement and improved access levels for students in the experimental group. Similarly, the results of the second study indicated that the flipped classroom approach, designed using Khan Academy and mathematics software, enhanced student achievement. Both studies demonstrate the potential of digital learning platforms to improve mathematics performance. The first study observed a significant increase in students' achievement levels and improved access levels. The second study highlighted the effectiveness of the flipped classroom approach in enhancing student achievement and understanding. However, there are some differences between the studies. While the first study utilized EBA as the control group, the second study employed traditional methods as the control group. Additionally, there were variations in the research groups and student levels. In conclusion, both studies indicate the positive effects of digital learning platforms on mathematics achievement. However, due to the differences in the studies, direct comparisons may be challenging. Further research incorporating different parameters can help us better understand the impact of digital learning platforms.

Kelly and Rutherford (2017) examined the use of Khan Academy as a mathematics intervention for seventh-grade students in a control group over a period of 4 weeks. In contrast to our study, Kelly and Rutherford's (2017) study did not find a statistically significant difference in student test scores between the experimental and control groups. However, the study did find significant relationships between the internal measurements used to monitor student performance and the usage of Khan Academy and student test scores. We can say that both studies show the positive effects of Khan Academy on mathematics learning. Comparisons between the studies are challenging due to the use of different parameters and methods, but this challenge provides opportunities for different research findings. Further research incorporating different controls can help us better understand the impact of Khan Academy.

Kelly's (2018) study found no difference between students receiving regular education with Khan Academy and students receiving only regular education. These different results may stem from variations in the research context, characteristics of the study groups, the tests used, and the analysis methods. Additionally, there may be differences in the instructional programmes and other variables used.

Different results may require further research and more in-depth analyses to understand the effects of different factors. Many studies aiming to enhance the effectiveness of instruction using the Khan Academy platform have shown positive results (Chu et al., 2018; Dickinson, 2016; Leon & Koosed, 2018; Makinde & Yusuf, 2017; Muir, 2014; Rueda-Gómez et al., 2023). It is important to interpret the results considering the methodology, sample size and characteristics, measurement tools used, and other factors. While interpretations in different contexts can shed light on future research, digital learning platforms have the potential to enhance effectiveness in practical applications.

The limitations of this research should also be taken into consideration. For instance, the number of students is limited to 60, which restricts the generalizability of the findings. Additionally, only one unit was focused on, and other mathematical topics were not considered. These are issues that need to be addressed in future research.

Based on the findings of this research, the following suggestions can be made:

Educators and curriculum designers should consider effectively using digital resources in mathematics classes. Online platforms such as Khan Academy can help students improve their mathematical skills. The use of such resources can enhance student achievement and support mathematics learning.

Teaching methods and materials should be carefully selected to enhance student achievement in specific topics like "Data Collection and Evaluation." This study found that activities conducted with Khan Academy increased the success of students in the experimental group. Therefore, it is recommended to incorporate similar activities in relevant topics.

Teachers can focus more on digital learning platforms to increase students' access levels. The results of the accessibility test indicate that students in the experimental group achieved higher levels of access through activities conducted with Khan Academy. This means that students can have better access to mathematical topics and improve their understanding.

Future research should conduct more comprehensive studies on different mathematical topics. This study focused only on the "Data Collection and Evaluation" unit. Similar research conducted on different topics can help us better understand the impact of digital learning resources in various areas of mathematics.

Research conducted on larger samples can enhance the generalizability of the results. In this study, the number of students was limited to 60. Research conducted on larger sample groups can provide more reliable interpretations of the results.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

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CRediT author statement

The study was single authored and the whole process was carried out by the corresponding author.

Research involving Human Participants and/or Animals

The study involves human participants. Ethics committee permission (Date: 18.08.2023, Number: E-23688910-050.01.04-2300084605) was obtained from Bartın University, Social and Human Sciences Research Ethics Committee.

Khan Academy Öğrenme Platformunun İlkokul 4. Sınıf Öğrencilerinin Matematik Başarısı Üzerindeki Etkisi

Özet:

Bu araştırma, Khan Academy öğrenme platformunun öğrencilerin matematik dersindeki başarısına etkisini incelemeyi amaçlamaktadır. Araştırmada ön test-son test kontrol gruplu desen kullanılarak deney ve kontrol gruplarının başarı düzeyleri arasındaki farklılık test edilmiştir. Çalışma grubu, destekleme ve yetiştirme kursuna devam eden ilkokul dördüncü sınıf öğrencilerden oluşmaktadır. Çalışma 60 öğrenciyle gerçekleştirilmiştir. Deney grubunda yer alan öğrencilere Khan Academy öğrenme platformu üzerinden matematik dersi içerikleri sunulmuş ve bu içerikleri kullanarak öğretim gerçekleştirilmiştir. Kontrol grubundaki öğrencilere ise Eğitim Bilişim Ağı (EBA) ile matematik dersi işlenmiştir. Öncelikle her iki gruba da ön test uygulanmış ve öğrencilerin başarı düzeyleri kaydedilmiştir. Ardından deney grubundaki öğrencilere Khan Academy öğrenme platformu tanıtılmış ve matematik derslerinde bu platformu kullanılmıştır. Kontrol grubundaki öğrenciler ise EBA tanıtılmış ve derslerde bu platform kullanılmıştır. Belirli bir süre sonra her iki gruba da son test uygulanmış ve öğrencilerin başarı düzeyleri tekrar ölçülmüştür. Elde edilen veriler kullanılarak deney ve kontrol gruplarının başarı düzeyleri arasındaki farklılık istatistiksel olarak analiz edilmiştir. Bu analiz sonucunda Khan Academy öğrenme platformunun öğrencilerin matematik dersindeki başarısına etkisinin daha fazla olduğu sonucuna ulaşılmıştır.

Anahtar kelimeler: Khan Akademi, Eğitim Bilişim Ağı (EBA), ilkokul, matematik, başarı.

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Research Article

The Effect of the Out-of-School Learning Environments Course in Teaching Mathematics on the Opinions of Teacher Candidates

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Abstract – In this study, it was aimed to determine the self-efficacy beliefs of elementary mathematics teacher candidates towards out-of-school learning activities and their thoughts about out-of-school learning environments before and after the out-of-school learning environments in mathematics teaching course. In line with this purpose, the effect of out-of-school learning environments course in mathematics teaching taught at the undergraduate level was examined. In the study, a mixed research method was adopted. The participants of the study consisted of 59 elementary mathematics teacher candidates studying in the 4th grade at a state university in Türkiye. "Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning Activities" and six open-ended questions about out-of-school learning environments were used as data collection tools. It was concluded that the out-of-school learning environments course in mathematics education had a positive effect on pre-service teachers' self-efficacy and their thoughts about out-of-school learning.

Key words: Mathematics teaching, out-of-school learning environments, self-efficacy, elementary mathematics teacher candidates.

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Introduction

Today, the progress in science and technology has affected all areas of life, as well as education and training. Within the framework of development and progress, new approaches and teaching methods are applied in the fields of education and training. In this context, one of the approaches used in education is constructivism. From a philosophical perspective, it is

stated that constructivism is based on the principles of progressivism (Keskin & Şahin, 2018). In other words, it is emphasized that the constructivist approach emerged depending on the progressive philosophy (Öztürk, 2013). The progressive perspective has a remarkable impact on curriculum today, as it focuses on students' thinking skills by centering their interests and needs, and one of its main points is that students are active throughout education (İlhan Beyaztaş et al., 2013). The main principles of the progressive philosophical perspective are such as (i) the individual is active in education, (ii) problem-solving is taken as the basis in education, (iii) school is life itself rather than preparation for life, (iv) the teacher's duty is to guide, (v) the school encourages students to cooperate, (vi) democratic education environment (Demirel, 2020a, p. 21-22). In this context, the nature of the constructivist approach, which adopts a student-centered perspective, has led to the opinion that out-of-school learning environments (OoSLE) should also be used in the teaching process (Yazıcı & Yıldırım, 2017).

It can be said that the use of different learning and teaching processes within the framework of the constructivist approach has opened the door to new dimensions in 21st-century education. One of these dimensions is teachers' utilization of different learning environments in teaching. Among different learning environments, there are also OoSLE. In the context of learning and sociocultural approach, the constructivist approach has become very popular in schools, especially in mathematics learning and teaching (Voskoglou, 2019). In the context of the social constructivist approach, it emphasizes that learning should take place not only in the classroom environment but also outside the school. Considering these developments, with the innovations in education and training, the idea that education cannot be limited only to school has emerged and that education should also be provided outside the school (Köseoğlu & Mercan, 2020). In this context, in order to understand individuals' mathematics learning, it is necessary to focus not only on the learning they do at school but also on the learning that takes place outside of school. Because, according to the report published by Life Center (2005), when the waking hours of individuals are examined, it is seen that they spend most of their lives (over 80% of the time they stay awake) in out-of-school environments. This also shows that learning is not only in classrooms at schools but that individuals also have learning experiences outside the classroom environment (Eshach, 2007; Sen et al., 2021). Within this regard, it can be said that the interactions of individuals in OoSLE and in school have an undeniable effect on individuals' mathematics learning.

Today, the measurement of 21st-century learning and the competencies and skills needed in this context is carried out with Programme for International Student Assessment (PISA) (Ananiadou & Claro, 2009). One of the main elements that PISA aims to measure is the extent to which students use the knowledge they learn at school in real life (Organisation for Economic Co-Operation and Development [OECD], 2019). When we focus on the results obtained in PISA, it becomes clear that students from most countries cannot adequately use the knowledge they have learned at school. Students can have the chance to associate the information they have learned with new information in different environments (Falk & Dierking, 2000). In other words, students can have the opportunity to understand what the information they have learned is useful in real life by having the chance to associate the information they have learned in the classroom environment with the experience they have gained outside of school. Activities held outside of school provide students with the opportunity to apply their academic skills in real life, contributing to the reinforcement of the knowledge they have learned in the classroom environment (O'Brien & Rollefson, 1995). In this context, activities carried out outside of school provide students with the opportunity to apply the mathematical knowledge they have learned in the classroom environment. It may offer the opportunity to use it in real life. Students' mathematical literacy levels can be improved within the framework of out-of-school learning (OoSL) experiences and activities to be carried out in this direction.

OoSLE provide awareness (Jarvis & Pell, 2005), develop skills of relating to real life (Ertaş et al., 2011; Tortop & Özek, 2013) and 21st century skills (Genç et al., 2019). In this context, OoSLE affect students' attitudes (Andersson & Johansson, 2013; Sturm & Bogner, 2010; Şentürk & Özdemir, 2014), interest (Bozdoğan, 2008; Bozdoğan & Yalçın, 2006; Morag & Tal, 2012) and motivation (Çığrık & Özkan, 2016), increase academic success (Bozdoğan, 2008; Bozdoğan & Yalçın, 2006; Guberman, 2004; Sturm & Bogner, 2010), contribute to acquiring values (Keskin & Kaplan, 2012) and develop 21st century skills (Altan et al., 2019). In the literature, there are many studies conducted with students, as well as with teachers and teacher candidates in OoSLE. Some studies emphasize that applications for OoSLE are rarely preferred by teachers (Aydoğdu et al., 2023; Carrier, 2009; Orion & Hofstein, 1994). In this context, no matter how well-prepared the curriculum and designed lesson plans are, they are only as effective as teachers can implement them (Göloğlu Demir & Çetin, 2021). Therefore, teachers' approaches to the subject, their attitudes, behaviors, and self-efficacy are considered important in terms of the effectiveness, efficiency, and

achievement of the planned goals of the course. Considering the problems in the field of mathematics education in today's 21st century age (not realizing what mathematics is used for in real life, where it can be used, not associating mathematics with real life, not associating mathematics within itself and with other disciplines, etc.), it is thought that the learning activities designed by teachers for OoSLE will open a door to the solution of these problems. In line with this, teachers' knowledge of OoSLE, their attitudes, and self-efficacy play an important role in carrying OoSL activities.

When the literature is examined, it is seen that while there are studies on OoSLE in areas such as science, preschool, and social studies, there are not enough studies on mathematics education. In other words, while there are many resources for disciplines such as science, history, and art for OoSLE, it is also emphasized in studies on mathematics that such resources are quite limited in number (Aydoğdu et al., 2023; Bahadır & Hırdıç , 2018; Kayhan Altay & Yetkin Özdemir, 2022). Saraç (2017) conducted a content analysis of research on OoSLE in Türkiye. He emphasized that the majority of studies on OoSL in the national arena are in the field of science, and excursions/nature practices and museum/science center visits are used more frequently. When Saraç's (2017) study is examined, it is seen that studies on OoSLE in mathematics education in Türkiye are not included at a sufficient level. One of the limited studies on OoSLE in the field of mathematics education is Kır et al. (2021). In the study, they tried to determine the opinions of teachers about the OoSLE used in mathematics lessons and the practices they carried out in OoSLE. In the study conducted with 12 secondary school mathematics teachers, it was revealed that almost all of the teachers did not receive any training regarding OoSLE. In addition, teachers did not have enough experience in education, event planning and planning for OoSL. In this context, they made suggestions for the development of teachers in related subjects. Similarly, another study was by Aydoğdu et al. (2023). The study examined secondary school teachers' opinions about OoSLE. As a result of the research, it was emphasized that teachers found OoSLE useful, but they expressed opinions that they had difficulty in implementing them due to legal procedures, time, and economic reasons. Among the striking results of the study is that teachers do not have enough information about OoSLE.

Studies on mathematics in the literature aim to determine teachers' opinions about OoSLE or activities. In this context, it can be said that the majority of studies on OoSL in mathematics teaching are aimed at determining the situation. While the "Out-of-School Learning Environments" course is included in the "Vocational Knowledge Elective Courses"

in the "New Teacher Training Undergraduate Programs" courses renewed in 2018, the "Out-of-School Learning Environments in Mathematics Teaching" course is among the field education elective courses in the elementary school mathematics teaching and mathematics teaching programs (Council of Higher Education [CoHE], 2018) In this study, focusing on why OoSLE should be included in mathematics teaching, the effect of the OoSLE course in mathematics teaching, which is taught as an elective course in the elementary school mathematics teaching program, on the self-efficacy and thoughts of teacher candidates towards OoSL was examined. The study differs from other studies in that it offers a perspective on how teacher candidate's activities, academic skills and self-efficacy towards OoSL in mathematics education can be improved.

Research Problem

What is the impact of the OoSLE course in mathematics teaching on teacher candidates' self-efficacy towards OoSL activities and their thoughts about OoSL?

Subproblems

1. What are teacher candidates' self-efficacy perceptions of OoSL activities and their thoughts on OoSL before the OoSLE course in teaching mathematics?

2. What are teacher candidates' self-efficacy perceptions of OoSL activities and their thoughts on OoSL after the OoSLE course in teaching mathematics?

3. Is there a significant difference between the self-efficacy of teacher candidates towards OoSL activities before and after the OoSLE course in mathematics teaching?

4. Is there a significant difference between the self-efficacy of teacher candidates for OoSL activities according to gender before and after the OoSLE course in mathematics teaching?

Method

Research Design

A mixed research method was adopted in this study, which examined the effect of the OoSLE course in mathematics teaching on the self-efficacy of teacher candidates towards OoSL activities and their thoughts about OoSLE. Mixed research is a research method that involves the combined use of qualitative and quantitative methods or features of other paradigms (Johnson & Christensen, 2014) and provides researchers with the opportunity to

collect more powerful data (Silverman, 2010). Creswell (2009) defines the mixed method as a method in which researchers collect data, perform analysis, present findings and make inferences by adopting qualitative and quantitative approaches in order to find answers to problems. In this context, it is thought that qualitative or quantitative data alone will not be sufficient to examine the effect of the OoSLE course in mathematics teaching within the framework of the opinions of teacher candidates.

It is thought that the effect of the OoSLE course can be determined more clearly by combining the results obtained from quantitative and qualitative methods, supporting and overlapping the findings. In this context, the triangulation model, one of the mixed research designs that allows comparisons to be made by combining the results obtained in line with the data obtained by collecting both quantitative and qualitative data, was preferred in this research. It can be said that this model corresponds to "Triangulation", one of the five aims of mixed research according to Greene et al. (1989). Using quantitative and qualitative methods together in triangulation model allows an in-depth examination of the subject under investigation by utilizing many research designs and many data sources (Cohen et al., 2007). One of the main goals of the triangulation design is to combine the results obtained in line with the data obtained from quantitative and qualitative methods. The quantitative part of this research is based on data obtained from the scale to determine the self-efficacy of teacher candidates for OoSL activities. The qualitative part was created within the framework of open-ended questions asked to the participants in order to determine the opinions of prospective teachers about OoSL in mathematics teaching.

Participants

The study group of the research consists of 59 teacher candidates who are studying in the last year of the elementary mathematics teaching program at a state university in Türkiye in the 2022-2023 academic year. Criterion sampling method, one of the non-random purposive sampling methods, was preferred in the research. The main purpose of criterion sampling is stated to be the study of situations that meet pre-existing criteria or are determined by the researcher (Yıldırım & Şimşek, 2016). In this regard, since the study carried out studies on the effect of the OoSLE course in mathematics teaching, the fact that the participants were taking the OoSLE course in mathematics teaching was determined as the selection criterion for the study group. In this context, the participants of the research are teacher candidates who took the OoSLE course in mathematics teaching as an elective course in the 4th grade and participated voluntarily. Table 1 includes the demographic characteristics of the study group:

Table 1 Demographic characteristics of teacher candidates

Have you participated in OoSL activities before?	Female	%	Male	%	Total	%
Yes	28	68.3	13	31.7	41	69.5
No	13	72.2	5	27.8	18	30.5
Total	41	69.5	18	30.5	59	100.0

Among the teacher candidates participating in the research, 41 were female (69.5%) and 18 were male (30.5%). While 69.5% (n=41) of the participants stated that they had participated in OoSL activities before, 30.5% (n=18) stated that they had not participated in any OoSL activities before. Of the teacher candidates who had previously participated in the activity for OoSLE, 18 stated that they participated in a school trip, 12 of them stated that they participated in the "pi day" event held at the place where they completed their undergraduate education, and 7 of them stated that they visited a museum.

Data collection

In order to determine the self-efficacy beliefs of teacher candidates towards OoSL activities before and after the course on OoSLE in mathematics teaching, the data of the study were obtained by asking "Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities" in the quantitative dimension and open-ended questions about "What are the OoSLE that can be used in mathematics teaching", "Advantages and disadvantages of OoSLE" and "What are the contributions of OoSLE to mathematics teaching" in the qualitative dimension.

Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities

“Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities” was developed by Göloğlu Demir and Çetin (2021). Six expert opinions were received to ensure the content validity of the scale, and expert opinion was sought for language and face validity. In the construct validity phase, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were applied. As a result of EFA, a structure consisting of 29 items and four factors was obtained, explaining 61.01% of the total variance. 15 of the items in the scale are positive and 14 are negative items. Reverse coding is required during the analysis phase of negative items. "Preparation Competence", which is one of the sub-dimensions of the scale, consists of 11 items, "Application and Evaluation Competence" consists of 10 items, "Learning Support Competence" consists of 4 items, and "Knowledge and Experience Competency" consists of 4 items. In line with the CFA results, it was stated that the scale had

"acceptable fit" and "perfect fit" indices. The reliability of the Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities, which is a five-point Likert type, was found to be .94 using the Cronbach alpha method. The Cronbach alpha reliability value of the scale for this study was .91 in the pre-test. In the post-test, it was calculated as .92.

Open-ended questions

9 open-ended questions were created before the research in order to determine teacher candidates' thoughts about OoSL in mathematics teaching, in parallel with their self-efficacy towards OoSL activities. The opinions of the faculty members including 1 Assoc. Prof. and 1 Dr. were taken for 9 open-ended questions. Within the framework of expert opinions, 3 questions were removed as it was seen that they did not reflect the purpose of the research. Afterwards, 6 open-ended questions were reviewed by 1 language expert to ensure face and language validity. The open-ended questions were finalized in line with the comments received. 2 of the open-ended questions were about "What are the OoSLE that can be used in mathematics teaching", 2 were about "The advantages and disadvantages of OoSLE", and 2 were about "What the contributions of OoSLE can be to teaching mathematics". It aims to reveal the opinions of the teacher candidates.

OoSLE Course Process in Teaching Mathematics

The OoSLE in mathematics teaching course is a 2-hour weekly course in the 14-week period in the elective course pool of the elementary school mathematics teaching program. The aim of the course is to introduce the process of teaching mathematics in OoSLE, to provide information about teaching methods and techniques that can be used in appropriate OoSLE for teaching mathematics, and to enable teacher candidates to develop, plan, implement, and evaluate sample activities that they can carry out for teaching mathematics in OoSLE. During the 14-week period, teacher candidates discussed what OoSL is, its importance, things to consider in OoSL activities, practices to be done before, during and after OoSL activities, and each teacher candidate designed at least one activity for OoSL in mathematics teaching and developed these designs. The lessons they shared have been realized.

Data Analysis

In order to provide flexibility in terms of data collection and to reach participants more easily via the web, the Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities and open-ended questions were transferred to the online environment using

Microsoft Forms application. In the stage before the application of the scale and open-ended questions, participants were informed through text that included explanations about the importance of reflecting their views and opinions clearly in order to achieve the purpose of the application, that participation was voluntary, and how they should mark the scale items. During the data collection phase, the threat posed to the validity of the measurement tools when they were applied (Creswell, 2009) was taken into account. In this context, an online meeting was planned with all participants at the same time to apply the data collection tools online, links to the data collection tools were shared with the participants, and data was obtained from all participants at the same time.

Analysis of Quantitative Data

The data obtained online was transferred to Microsoft Excel format via Microsoft Forms. The Excel form includes participants' demographic information, their answers to open-ended questions, and their answers to the Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities. The demographic characteristics of the participants and the data obtained from the scale were transferred to the quantitative data SPSS application. The items of the scale, which is a 5-point Likert type, were coded with SPSS application in line with the coding criteria in the scale, with "I Strongly Disagree" 1 point, "I Disagree" 2 points, "Somewhat Agree" 3 points, "I Agree to a Great extent" 4 points, "Totally Agree" 5 points. Reverse coding was performed for 14 negative items on the scale. The lowest score that can be obtained on the scale consisting of 29 items is 29 and the highest score is 145. In line with the total scores obtained from the scale, "Score range (largest value - smallest value) / (number of degrees)" was used to evaluate the self-efficacy beliefs of teacher candidates towards OoSL activities as very low, low, medium, high and very high. The calculation was carried out in accordance with the formula (Tavşancıl, 2005). In this context, the values between 29-52.2 points for the total scores obtained from the scale are very low, 52.3--75.4 points are low, 75.5-98.6 points are medium, and 98.7-121.8 points are high and a score between 121.9 and 145 was considered as very high self-efficacy. Within the framework of this scoring, the level of self-efficacy of teacher candidates is revealed.

In determining the significant difference between the pre-test scores and post-test scores for the analysis of quantitative data obtained from “the Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities”, the normality of the data group was first examined. The reason for this situation is the decision on the analysis method to be

performed. By examining the normal distribution, it was decided whether parametric or non-parametric methods would be used to determine the difference (Büyüköztürk, 2013; Karasar, 2008). In examining the normality of the data group, Lilliefors, Chi-square, Anderson-Darling, Skewness, Kurtosis, D' Agostino-Pearson, Kolmogorov -Smirnov and Shapiro Many tests such as Wilk tests are encountered (Özer, 2007). In this study, Skewness and Kurtosis values were examined to determine whether the data groups showed normal distribution. According to Tabachnick and Fidell (2013), skewness and kurtosis values being between 1.5 and +1.5 indicate that the data is normally distributed. Within the framework of this information, the skewness and kurtosis values of the pre-test and post-test scores of the teacher candidates were examined and it was seen that these values were between -1 and +1, and it was concluded that the data showed a normal distribution. Similarly, according to the pre-test and post-test, it was determined that the skewness and kurtosis values of the total scores in terms of gender variable were between -1 and +1.

According to the normality analysis, it was determined that the pre-test and post-test scores of the Teacher Self-Efficacy Beliefs Scale for Out-of-School Learning (OoSL) Activities and the total scores in terms of gender variable showed a normal distribution. Within the framework of these findings, t-test for related samples was used to determine the significant difference between pre-test and post-test scores, and t-test analyzes for independent samples were used to determine the significant difference between pre- test and post-test scores in terms of gender variable.

Analysis of Qualitative Data

The qualitative data of the research were obtained from the answers given to seven open-ended questions directed to teacher candidates. The content analysis method was used to analyze qualitative data. Content analysis is a research method that aims to make repeatable and valid inferences from texts or other topics regarding the contexts in which they are used (Krippendorff, 2018). One of the main purposes of content analysis is to obtain concepts and relationships that can explain the data (Selçuk et al., 2014). In this context, within the framework of a research technique, content analysis provides information about situations by increasing the researcher's understanding of certain situations by providing new insights (Krippendorff, 2018). In this context, content analysis brings together seemingly separate data within the framework of certain codes and themes and organizes them in a way that readers can understand (Yıldırım & Şimşek, 2016).

The answers given by teacher candidates to open-ended questions were evaluated within the context of "What are the OoSLE that can be used in mathematics teaching?", "Advantages and disadvantages of OoSLE" and "What is the role of the teacher in OoSLE and what can be their contributions to mathematics teaching?" After transferring the answers obtained via Microsoft Forms to the Excel document, content analysis was carried out on the answers given to the open-ended questions. The opinions of each teacher candidate were protected by expressing them as T1, T2, T3… in order to keep the identities of the people who expressed their opinions confidential (Cohen et al., 2007). In line with the opinions of teacher candidates, codes were created for each question regarding the topics it relates to. The codes are presented through tables in order to make sense of the codes created, to ensure the comprehensibility of the data, and to present them in a framework that the reader can understand. In addition, the opinions of teacher candidates regarding some analyses were directly quoted and code examples for the data were also presented.

To provide validity and reliability criteria for the research; (i) data collection and analysis processes were explained in detail, (ii) frequency tables within the framework of the codes were created and participant opinions regarding the codes were presented by direct quotations, and (iii) the researcher conducted content analysis again 4 weeks after performing the first coding and reliability analysis was performed for the coding determined. In order to reveal the reliability of the qualitative data in the analyses carried out by the researcher at two different times, calculations for reliability analysis were carried out using Miles and Huberman's (1994) security level formula (reliability = consensus/consensus + disagreement). The reliability of the coding performed by the researcher at different times was calculated as 94%. According to Yıldırım and Şimşek (2016), 70% reliability is considered sufficient for the reliability of analysis results.

Findings

Findings regarding the first sub-problem

The first sub-problem of the study aims to determine the level of elementary school mathematics teacher candidates' self-efficacy towards OoSL activities and their thoughts on OoSL before the OoSLE course in mathematics teaching. First of all, the findings obtained regarding the teacher candidates' out-of-school self-efficacy levels in pre-lesson mathematics teaching and their thoughts on OoSLE in mathematics teaching are given below. Teacher candidates' thoughts on OoSLE in teaching mathematics include "What are the OoSLE that

can be used in teaching mathematics?", "The advantages and disadvantages of OoSLE", "The role of the teacher in OoSLE" and "What the contributions of OoSLE can be to teaching mathematics." are presented within the framework of categories. In this context, teacher candidates' self-efficacy levels in teaching mathematics before OoSLE course are presented in the Table 2:

Table 2 Self-efficacy level before the course

Gender	Very low	%	Low	%	Moderate	%	High	%	Very High	%	Total
Female	-	-	-	-	13	31.7%	28	68.3%	-	-	41
Male	-	-	-	-	5	27.8%	13	72.2%	-	-	18
Total	-	-	-	-	18	30.5%	41	69.5%	-	-	59

70% of elementary school mathematics teacher candidates had high levels of self-efficacy beliefs regarding out-of-school activities in mathematics teaching. There are no teacher candidates with very low, low, or very high levels of self-efficacy. 30.5% (n=18) of teacher candidates have a moderate level of self-efficacy belief. According to the findings in Table 2, it can be stated that the results are close to each other in the context of the gender variable.

Findings regarding "What are the OoSLE that can be used in mathematics teaching" before the course

Before the lesson on OoSLE in teaching mathematics, teacher candidates were asked open-ended questions including "What are OoSLE?" and "What are OoSLE that can be used in teaching mathematics?". Findings regarding the OoSLE of teacher candidates are presented in the Table 3:

Table 3 Opinions about the OoSLE before the course

OoSLE	N	%	OoSLE	N	%
Museums	23	38.98	Park	2	3.39
Any environment planned for the purpose	14	23.73	Planetarium	1	1.69
School Trips	10	16.95	Fairs	1	1.69
Science/Art Center	7	11.86	House	1	1.69
Zoo	6	10.17	National parks	1	1.69
Botanical Gardens	4	6.78	Science festivals	1	1.69
Conference/Workshop/Seminars	4	6.78	Historical places	1	1.69
Nature	4	6.78	Bank	1	1.69
Library	4	6.78	Schoolyard	1	1.69
The whole sphere of life	3	5.08	No idea	5	8.47
Exhibitions	2	3.39			

As shown in Table 3, before the course on OoSLE in teaching mathematics, approximately 40% of the teacher candidates stated that museums (n=23) could be used in OoSLE. Afterwards, 23.73% of the teacher candidates stated that " any environment planned for the purpose" (n=14, 23.73%) could be used as OoSLE. According to Table 3, among the striking findings is that school trips (n=10, 16.95%) are considered as OoSLE, and five teacher candidates declared that they have no idea.

The findings regarding the OoSLE that can be used for mathematics teaching are presented in the Table 4:

Table 4 Opinions on OoSLE in mathematics teaching before the course

OoSLE in mathematics teaching	N	%	OoSLE in mathematics teaching	N	%
Museums	20	33.90	Jeweler	2	3.39
Bank	14	23.73	Math Village	2	3.39
Factories/Industrial Establishments	11	18.64	Schoolyard	2	3.39
Science arts center	8	13.56	Library	2	3.39
Everywhere (All place)	7	11.86	Stationary	1	1.69
Science Festivals	5	8.47	Book fairs	1	1.69
Trips	5	8.47	Mathematics Exhibitions	1	1.69
Markets	5	8.47	Gym	1	1.69
Notary	4	6.78	Field	1	1.69
Shopping mall	3	5.08	House	1	1.69
Construction Sites	3	5.08	Observatory	1	1.69
Parks	3	5.08	Historical buildings	1	1.69
Nature	3	5.08	Conference	1	1.69
Workplaces	2	3.39	No idea	5	8.47

When Table 4 is examined, it is seen that teacher candidates consider many areas such as museums (n=20, 33.90%), banks (n=14, 23.73%), factories/industrial establishments (n=11, 18.64%), science and art centers (n=8, 13.56%) as OoSLE that can be used in mathematics teaching. According to the findings, 12% of teacher candidates see all places outside the school (n=7) as OoSLE in teaching mathematics. The fact that the trip (n=5, 8.47%) is considered as an OoSLE stands out in the findings. Approximately 9% of teacher candidates emphasized that they had no idea.

Findings on the advantages and disadvantages of OoSLE before the course

One of the questions asked to teacher candidates in order to reveal the effect of the OoSLE course in mathematics teaching is about the advantages of OoSLE. The findings

obtained as a result of the content analysis of the answers given by teacher candidates regarding the advantages of OoSLE are presented in the Table 5:

Table 5 Opinions on the advantages of OoSLE before the course

Advantages of OoSLE	N	%
Permanent learning	24	40.68
Learning by doing	11	18.64
Concretization	9	15.25
Relation to real life	9	15.25
Attracting Interest/Attention	4	6.78
Understanding the function of the course in real life	4	6.78
Meaningful Learning	3	5.08
Making Lesson Fun	3	5.08
Ability to apply what you have learned	2	3.39
Developing positive attitude	1	1.69
Association with different disciplines	1	1.69
Effective Teaching	1	1.69
No Idea	2	3.39

According to Table 5, the majority of teacher candidates (40.68%) stated that OoSLE provide permanent learning. Teacher candidates stated that OoSLE contributed to areas such as learning by doing and experiencing (n=11, 18.64%), concretizing concepts (n=9, 15.25%), relation to real life (n=9, 15.25%), attracting students' interest and attention (n= 4, 6.78%), understanding the function of the course in real life (n=4, 6.78%), etc. Some opinions of teacher candidates regarding the themes created in Table 5 are presented below:

T22: "*It ensures permanent learning of the student. It accelerates the learning process by associating abstract information in your mind with concrete information*." (Permanent learning and concretization)

T39: "*Outside of school, the student is more in touch with the subject and learns by doing and experiencing. A student's interest and curiosity in out-of-school environments keeps him/her committed to the activity*." (Learning by doing and Attracting Interest/Attention)

T11: "*It enables students to associate what they have learned with real life*." (Relation to real life)

Findings regarding the disadvantages of OoSLE within the framework of the opinions of teacher candidates are given in the Table 6:

Table 6 Opinions on the disadvantages of OoSLE before the course

Disadvantages of OoSLE	n	%
Time	14	23.73
Class dominance and order may not be achieved	13	22.03
Economic	11	18.64
Unfavorable learning environment	9	15.25
Inability to focus on the subject	9	15.25
Learning that differs from its purpose may occur	4	6.78
Bureaucratic difficulties (Permits, official correspondence, etc.)	4	6.78
No idea	3	5.08

When the Table 6 is examined, the most stated disadvantage by teacher candidates regarding OoSLE is time (n=14, 23.73%). Moreover, it was emphasized that " Class domination and order may not be achieved" (n=13, 22.03%) and economic difficulties (n=11, 18.64%) may be encountered because the activity requires a certain amount of budget. Approximately 15% of the teacher candidates think that the OoSLE may be problematic in terms of readiness, suitability to the learning outcome, health, etc., and that these environments may turn into an unfavorable learning environment (n=9, 15.25%). As another disadvantage of OoSLE, teacher candidates stated that students may encounter a situation of "Inability to focus on the subject" (n=9, 15.25%), thinking that different phenomena other than the main purpose may attract their attention in these environments. Some teacher candidates' opinions regarding the findings in the Table 6 are given below:

T17: *"Too much time may be wasted."* (Time)

T50: *"Crowded classes can be difficult to keep under control."* (Class dominance and order may not be achieved)

T24: *"It may be costly and time-consuming"* (Economic and Time)

T29: *"There may be some limitations. An event may not take place in every environment, they may be harmful to health and psychology."* (Unfavorable learning environment)

T54: *"Students' interest and attention can be quickly distracted"* (Inability to focus on the subject)

Findings regarding the role of the teacher in OoSLE before the course and the contributions of OoSLE to mathematics teaching

Another situation examined in the study within the framework of the first research problem is the examination of teacher candidates' thoughts about the role of teachers in OoSLE before the course. As a result of the analysis, the findings regarding the role of teachers in OoSLE of teacher candidates are given in the Table 7:

Table 7 Opinions on the role of teachers in OoSLE before the course

The Role of the Teacher	N	%
Guide	40	67.80
Determining the OoSLE	7	11.86
Planner	6	10.17
Designing/organizing activities	5	8.47
Taking security precautions	4	6.78
Provides meaningful/permanent learning	1	1.69
Educate acquisitions	1	1.69
Providing acquisition-place matching	1	1.69
Establishing a relationship between information and the environment	1	1.69
No Idea	3	5.08

68% of teacher candidates are of the opinion that the teacher's role in OoSLE is to guide (n=40). Then, it was stated that they had the roles of determining the OoSLE (n=7, 11.86%), carrying out all kinds of planning (n=6, 10.17%), and designing/organizing activities (n=5, 8.47%). Some answers from teacher candidates regarding the role of the teacher in OoSLE in mathematics teaching are presented below:

T4: *"The teacher should be a guide and pathfinder"* (Guide)

T23: *"They determine the environments that meet the learning goals of the students and show the information that the students need to learn in these environments."* (Determining the OoSLE and guide)

T13: *"The teacher should make correct plans before, during, and after the lesson in order for the students to stick to the goal."* (Planner)

Another situation examined in the study is the contribution of teacher candidates' OoSLE to mathematics teaching. In this context, the findings obtained from teacher candidates are presented in the Table 8:

Table 8 Opinions on the contribution of OoSLE to mathematics teaching before the course

Contribution	N	%
Permanent learning	23	38.98
Concretization	13	22.03
Relating mathematics to real-life	9	15.25
Realizing the function of mathematics in real life	8	13.56
Learning by doing	6	10.17
Attracting Interest/Attention	5	8.47
Making math fun	3	5.08
Making learning easier	3	5.08
Eliminating prejudices against mathematics	2	3.39
Active participation	2	3.39
Making you love mathematics	1	1.69
Motivation	1	1.69
Meaningful learning	1	1.69
No Idea	3	5.08

The most frequently expressed opinion of teacher candidates regarding the contribution of OoSLE to mathematics teaching is that OoSLE support permanent learning (n=23). Approximately 39% of teacher candidates think that OoSLE will provide permanent learning in mathematics education. Approximately 22% of teacher candidates emphasize that concretization in mathematics can be achieved through OoSLE. 15.25% of the participants stated that mathematics could be relating to real life through OoSLE. Additionally, 13.56% of teacher candidates emphasized that realizing the function of mathematics in real life can be achieved through OoSLE. The opinions of some participants regarding these findings are given below:

T5: *"It provides permanent learning by associating mathematics with daily life."* (Associating with real life and permanent learning)

T40: *"Since there are many abstract concepts in mathematics, these activities help to concretize them."* (Concretization)

T26: *"Mathematics is not only taught in class; It is learned by observing and seeing it used in daily life."* (Realizing the function of mathematics in real life)

Findings regarding the second sub-problem

The second sub-problem of the research aims to determine the level of elementary school mathematics teacher candidates' self-efficacy towards OoSL activities after OoSLE course in mathematics teaching and their thoughts on OoSL. First of all, teacher candidates' self-efficacy levels for after-course OoSL activities are presented in the Table 9:

Table 9 Self-efficacy level after the course

Gender	Very low	%	Low	%	Moderate	%	High	%	Very High	%	Total
Female	-	-	-	-	-	-	24	58.5%	17	41.5%	41
male	-	-	-	-	-	-	11	61.1%	7	38.9%	18
Total	-	-	-	-	-	-	35	59.3%	24	40.7%	59

After the OoSLE course in mathematics teaching, 40.7% of the teacher candidates reached a very high level of self-efficacy (n=24), which is the highest level. It can be seen in the Table 9 that the teacher candidates with a very high level of self-efficacy are 17 female and 7 male. 59.3% of teacher candidates have a high level of self-efficacy for OoSL activities. There are no teacher candidates with moderate-level proficiency after the course.

Findings regarding "What are the OoSLE that can be used in mathematics teaching" after the course

The findings of the answers given by the pre-service teachers about the OoSLE after the course are presented in the Table 10:

Table 10 Opinions about the OoSLE after the course

OoSLE	N	%	OoSLE	N	%
Environments outside the classroom planned for the purpose	28	47.46	Botanical gardens	4	6.78
Science/Art Centers	15	25.42	Natural protected areas	4	6.78
Museums	12	20.34	Non-governmental organizations	3	5.08
Places outside the classroom	10	16.95	Schoolyard	2	3.39
Historical places	10	16.95	Ruins	1	1.69
Planetarium	8	13.56	Environments where students can learn while having fun	1	1.69
Parks	7	11.86	Recreation areas	1	1.69
Factories/Industrial Establishments	5	8.47	Virtual classes	1	1.69
Libraries	4	6.78	Zoos	1	1.69
Universities	4	6.78			

According to Table 10, almost half of the pre-service teachers see OoSLE as "environments outside the classroom planned for the purpose". Subsequently, teacher candidates consider science/art centers (n=15, 25.42%), museums (n=12, 20.34%), any place outside the classroom (n=10, 16.95%), historical places (n=10, 16.95%), planetarium (n=8, 13.56%) as OoSLE.

Teacher candidates' opinions about OoSLE that can be used for teaching mathematics are given in the Table 11:

Table 11 Opinions on OoSLE in mathematics teaching after the course

OoSLE in mathematics teaching	N	%	OoSLE in mathematics teaching	N	%
Anywhere that can be associated with profit	28	47.46	Natural protected areas	5	8.47
Museum	27	45.76	Field-Garden	5	8.47
Science/Art Center	27	45.76	Banks	5	8.47
Factories/Industrial Establishments	22	37.29	Libraries	5	8.47
Parks	18	30.51	Historical places	4	6.78
Planetarium	14	23.73	Laboratories	4	6.78
Zoos	12	20.34	Universities	4	6.78
Public Institutions and organizations	8	13.56	Virtual Classroom	3	5.08
Technoparks	7	11.86	Market	2	3.39
Science Festivals	6	10.17	Schoolyard	2	3.39
Mosque	6	10.17	Ruins	1	1.69
Botanical Gardens	5	8.47	Shopping malls	1	1.69

According to the findings in Table 11, almost half of the teacher candidates stated that OoSLE in mathematics teaching can be carried out wherever a relationship can be established with the learning outcomes. Teacher candidates stated that places such as museums (45.76%), science/art centers (45.76%), factories/industrial establishments (37.29%), parks (30.51%), planetarium (23.73%), zoos (20.34%) are OoSLE that can be used in mathematics teaching.

Findings on the advantages and disadvantages of OoSLE after the course

Another question asked to teacher candidates in order to determine the effect of the OoSLE course in mathematics teaching is about the advantages and disadvantages OoSLE. In this context, findings regarding the advantages provided by OoSLE are presented in Table 12:

Table 12 Opinions on the advantages of OoSLE after the course

Advantages of OoSLE	N	%	Advantages of OoSLE	N	%
Permanent learning	39	66.10	Students learn at their own pace	2	3.39
Learning by Doing	14	23.73	Physical Skill Development	1	1.69
Making the course fun	12	20.34	Understanding relationships with ecology	1	1.69
Active Participation	10	16.95	Self-confidence boost	1	1.69
Motivation	9	15.25	Supporting lifelong learning	1	1.69
Attracting Interest/Attention	6	10.17	Supporting 21st-century skills	1	1.69
Relating to real life	5	8.47	Making teaching easier	1	1.69
Understanding the importance of the course in real life	4	6.78	Learning different forms of representation	1	1.69
Positive Attitude	3	5.08	Supporting students' personal development	1	1.69
Eliminating prejudices against the course	3	5.08	Increasing collaboration	1	1.69
Concretization	3	5.08	Values education	1	1.69

Improving Communication Skills	2	3.39	Giving opportunities to examine objects or situations that cannot be brought into the classroom	1	1.69
Improving social skills	2	3.39			

According to the findings in Table 12, 66.10% of teacher candidates think that OoSLE provide permanent learning. Besides, learning by doing OoSLE (n=14, 23.73%), making the course fun (n=12, 20.34%), active participation (n=10, 16.95%), motivation (n=9, 15.25%)), OoSLE are advantageous in situations such as attracting interest/attention (n=6, 10.17%). Below are some opinions of teacher candidates regarding the advantages of OoSLE:

T3: *"More permanent learning occurs for students. "Students see where what they learn in class will be encountered in daily life."* (Permanent learning, understanding the importance of the course in real life)

T28: *"It helps the student learn the subject in a more permanent way by doing and experiencing it."* (Learning by doing, permanent learning)

T33: *"It makes the lesson more fun for the student because it is outside the school…"* (Making the lesson fun)

Findings regarding the disadvantages of OoSLE, in line with the thoughts of teacher candidates after the course, are given in Table 13:

Table 13 Opinions on the disadvantages of OoSLE after the course

Disadvantages of OoSLE	N	%
Time	22	37.29
Economic	20	33.90
Class dominance and order may not be achieved	18	30.51
Bureaucratic difficulties (Permits, official correspondence, etc.)	11	18.64
It may lead to misconceptions	7	11.86
Considering the activity only as a trip	7	11.86
Shift of interest to another direction	6	10.17
Security	5	8.47
Failure to achieve the intended goal	4	6.78
Unfavorable learning environment	3	5.08
Failure to determine the appropriate environment	2	3.39
Teacher's lack of knowledge about out-of-school environments	1	1.69
Lack of preparation for the event	1	1.69

After the OoSLE course, teacher candidates mentioned that among the disadvantages of OoSLE, time (n=22, 37.29%) was the biggest disadvantage. Teacher candidates stated that

economic situations (n=20, 22.90%), class dominance and order may not be achieved (n=18, 30.51%), bureaucratic difficulties (n=11, 18.64%), situations that may lead to misconceptions when proper planning cannot be made (n=7, 11.86%), considering the activity only as a trip (n=7, 11.86%) are disadvantages. Some opinions of teacher candidates regarding these findings are given below:

T18: *"Too much time is spent. Financial means may be insufficient."* (Time, economy)

T21: *"It can be difficult to maintain control when we go on a crowded trip."* (Class dominance and order may not be achieved)

T40: *"Permissions and arrangements that need to be taken during the preparation process may discourage the teacher."* (Bureaucratic difficulties)

Findings regarding the role of the teacher in OoSLE before the course and the contributions of OoSLE to mathematics teaching

Another situation related to the second sub-problem of the research is the thoughts of teacher candidates after the course about the role of teachers in OoSLE and their contributions to mathematics teaching. In this context, findings regarding the role of teachers in OoSLE of teacher candidates are presented in Table 14:

Table 14 Opinions on the role of teachers in OoSLE after the course

The Role of the Teacher	N	%
Guide	50	84.75
Planner	20	33.90
Providing acquisition-place matching	10	16.95
Getting the permits	6	10.17
Enabling students to discover knowledge	4	6.78
Providing solutions to problems that may be encountered	3	5.08
Provides method diversity	3	5.08
Familiar with the OoSLE	3	5.08
Taking security precautions	3	5.08
Relating concepts to real-life	3	5.08

According to Table 14, approximately 85% of teacher candidates emphasized the guiding role of teachers in OoSLE. Teacher candidates see the roles of OoSLE teachers as planners (n=20, 33.90%), providing acquisition-place matching (n=10, 16.95%), and as getting permission for OoSL activities (n=6, 10.17%). The opinions of some teacher candidates regarding the findings are given below:

T31: *"…In out-of-school learning environments, the teacher is not the one who transfers knowledge, but the one who helps the student in the learning process. He is in the position of a guide."* (Guide)

T48: *"The process must be managed well. Must make good planning. Must obtain necessary permits. He/she should know the out-of-school learning environment well."* (Planner, Getting the permits and Familiar with the OoSLE)

T35 : *"The teacher must be able to match the outcomes and spaces well."* (Providing acquisition-place matching)

Findings regarding teacher candidates' thoughts on the contributions of OoSLE to mathematics teaching after the course on OoSLE in mathematics teaching are presented in Table 15:

Table 15 Opinions on the contribution of OoSLE to mathematics teaching after the course

Contribution	N	%	Contribution	N	%
Permanent learning	24	40.68	Physical skill development	1	1.69
Concretization	17	28.81	Development of communication skills	1	1.69
Eliminating prejudices against mathematics	13	22.03	Problem-solving	1	1.69
Making math fun	11	18.64	Analytical thinking	1	1.69
Realizing the function of mathematics in real life	9	15.25	Critical thinking	1	1.69
Attracting Interest/Attention	9	15.25	Taking responsibility	1	1.69
Learning by doing	8	13.56	Eliminate your fear of math	1	1.69
Relating mathematics to real-life	7	11.86	Making teaching easier	1	1.69
Positive attitude	5	8.47	Increasing self-confidence	1	1.69
Meaningful learning	3	5.08	Improving mathematical literacy,	1	1.69
Active participation	3	5.08	Realizing the relationship between mathematics and art and aesthetics	1	1.69
Developing a different perspective	2	3.39	Enabling self-paced learning	1	1.69
Motivation	2	3.39	Examining objects and situations that cannot be brought into the classroom	1	1.69

According to Table 15, 40% of the teacher candidates think that OoSLE will contribute to mathematics teaching in the context of permanent learning (n=24). The participants also emphasized that OoSLE contribute to mathematics education in terms of concretization (n=17, 28.81%), eliminating prejudices against mathematics (n=13, 22.03%), making mathematics fun (n=11, 18.64%), realizing the function of mathematics in real life (n=9,

15.25%), and attracting interest/attention (n=9, 15.25%). Examples of some of the teacher candidates' views are given below:

T12: *"As students participate voluntarily, their motivation increases and permanent learning is achieved."* (Motivation, permanent learning)

T31: *"Mathematics is an abstract course due to its structure. In this respect, it is considered a course that students have difficulty understanding. Out-of-school learning environments provide students with the experience of learning by doing. This experience enables the student to consider abstract mathematical concepts in a concrete context."* (Concretization, learning by doing)

T34: *"It eliminates the perception of students who see mathematics as an abstract and boring lesson. More effective and permanent learning occurs because concrete experiences occur."* (Concretization, Permanent learning, eliminating prejudice against mathematics)

Findings regarding the third sub-problem

The third sub-problem of the research is about whether there is a significant difference between the self-efficacy of teacher candidates towards OoSL activities before and after the OoSLE course in mathematics teaching. The results of the t-test analysis for related samples conducted in this context are presented in Table 16:

Table 16 T test result to determine the difference between pre-test and post-test scores

Tests	N	M.	SD	df	t	p *
Pre-test	59	102.25	9.50	58	-7.92	.00
Post-Test	59	115.05	11.05			

*p<.05

When the results of the t-test analysis for related samples are examined, it is seen that the significance level (p=.00) is lower than the significance value (p<.05). According to this finding, it can be said that there is a significant difference between teacher candidates' self-efficacy for OoSL activities before the OoSLE course in teaching mathematics and their self-efficacy after the course (t=-7.92, p=.00, p<.05). It can be seen in Table 16 that there is a significant difference between the teacher candidates' self-efficacy score average after the OoSLE course ($M_{post\text{-}test}$ = 115.05) and their pre-test self-efficacy score average ($M_{pre\text{-}test}$ = 102.25). These results show that the OoSLE course in mathematics teaching has a positive effect on teacher candidates' self-efficacy beliefs regarding OoSL activities.

Findings regarding the fourth sub-problem

It was determined that the data groups showed a normal distribution in determining the significant difference between the self-efficacy of teacher candidates for OoSL activities according to gender before and after the OoSLE course in mathematics teaching. In this context, before the course, t-test analysis for unrelated samples was performed to examine the significant difference between the self-efficacy of teacher candidates for OoSL activities according to gender. The findings for the t-test analysis are presented in the Table 17:

Table 17 T test result according to pre-tests in terms of gender

Pre-test	N	M.	SD	df	t	p
Female	41	101.85	8.86	57	.-49	.63
Male	18	103.17	11.04			

p >.05

In the t-test analysis for unrelated samples conducted according to the gender variable in the context of pre-tests, it was determined that the variances were equal according to Levene's Test. In the t-test analysis examined in this context, it was seen that the significance level (p=.63) was greater than the significance value (t=.-49, p=.63, p>.05). According to this finding, it can be said that there is no significant difference between the self-efficacy of teacher candidates towards OoSL activities in terms of gender variable before the lesson. According to Table 17, although the mean score of male teacher candidates (M_{male} = 103.17) was higher than the mean score of female teacher candidates (M_{female} = 101.85) before the course, this is not a statistically significant difference according to the t-test results.

Another situation examined within the scope of the fourth sub-problem is whether there is a significant difference between the self-efficacy of teacher candidates towards OoSL activities according to the gender variable after the OoSLE course in mathematics teaching. To determine whether there is a significant difference, t-test analysis was performed for unrelated samples and the findings are given in the Table 18:

Table 18 T test result according to post-tests in terms of gender

Post-test	N	M.	SD	df	t	p
Female	41	114.61	10.47	57	.-46	.65
Male	18	116.06	12.51			

p >.05

According to the analysis of the data obtained from the "Teacher Self-Efficacy Beliefs Towards Out-of-School Learning (OoSL) Activities" scale applied to teacher candidates after the OoSLE in mathematics teaching course, no significant difference was found in terms of gender in post-tests (t=.-46, p=.65, p>.05). Although the mean scores of male pre-service teachers (M_{male}= 116.06) were higher than the mean scores of female pre-service teachers (M_{female}= 114.61) in the post-tests as in the pre-tests, this was not sufficient for a significant difference.

Discussions and Conclusion

In today's 21st century, which is referred to as the age of information and technology, teachers are expected to use various methods and techniques in the context of rich learning and teaching processes, taking into account the needs of the age and the expectations of societies (Göloğlu Demir & Çetin, 2021). It can be said that these methods and techniques include using OoSLE in teaching activities. However, there are studies showing that teachers do not have a sufficient tendency to carry out activities outside of school (Carrier, 2009; Aydoğdu et al., 2023) and although students want out-of-school activities to be more frequent, such activities are carried out occasionally (Fűz, 2018). In the study carried out in the light of this information, elementary school mathematics teacher candidates' self-efficacy beliefs regarding OoSL activities and their thoughts about OoSLE were determined before and after the OoSLE course. In line with the purpose, the effect of the OoSLE course on mathematics teaching at the undergraduate level was also revealed.

Mathematics teacher candidates take many courses regarding the field, field education and professional knowledge during their undergraduate education. In addition, the development of prospective teachers in the field, field education and general cultural knowledge is supported through elective courses. Teacher candidates are often given little or no training on how to integrate or incorporate OoSLE into their curriculum (Johnson & Chandler, 2009). First of all, in the research, it was determined that although the majority of teacher candidates participated in OoSL activities before the lesson, all participants had not received any training on OoSL before. If the participants had not chosen the optional OoSLE course, they would not have received training on OoSLE during their undergraduate education. This situation was reported by Aydoğdu et al. (2023) and Kır et al. (2021) studies, this appears as an indication that mathematics teachers have not received training for OoSLE before. In addition, some of the teacher candidates who stated that they had participated in

OoSL activities before stated that they participated in the "pi day activities". In this context, it can be said that the "pi day activities" that teacher candidates participate in cannot be fully evaluated within the scope of out-of-school activities, as they are activities carried out individually and are not aimed at achieving a specific goal. Apart from this, the museum visits that teacher candidates attend before the lesson can be considered as OoSL activities. Therefore, it is seen that the majority of teacher candidates did not fully participate in OoSL activities in the past.

Before the course on OoSLE in mathematics teaching, it was determined that the self-efficacy of teacher candidates towards OoSL activities in mathematics teaching was at a moderate level in some teacher candidates, but the majority was at a high level. There are no teacher candidates who have very high self-efficacy beliefs, which is the highest level before the lesson. This finding is similar to the findings of the studies conducted by Bolat and Köroğlu (2022) with the Turkish language and literature teachers, Fırat Durdukoca (2023) with pre-service elementary education teachers, Demir and Çetin (2022) with teachers, and Demirel (2020b) with pre-service elementary education teachers. The reason why teacher candidates do not have a very high level of proficiency may be because they do not have enough knowledge of OoSL activities or they have not received training in this direction before. Although teachers participate in many out-of-school activities, the fact that they do not have sufficient knowledge and experience to carry them out (Tal & Morag, 2009) affects their self-confidence in OoSL activities. Another reason may be that they do not have experience in how to carry out their extracurricular activities. Regarding this situation, Olson et al. (2001) state that experienced teachers, like insufficiently experienced teachers, do not have enough knowledge about OoSLE. Therefore, the lack of adequate training for teachers and teacher candidates regarding OoSL activities (Johnson & Chandler, 2009) may prevent them from being self-confident in OoSL activities.

It was observed that teacher candidates' self-efficacy beliefs regarding OoSL activities in mathematics teaching increased after the course. While there were no teacher candidates with a very high level of proficiency before the course, it was determined that 40% of the teacher candidates had the highest level of proficiency after the course. This increase in the self-efficacy of teacher candidates can be explained by the positive effect of the OoSLE course in mathematics teaching. As a matter of fact, the results of the related samples t-test analysis support this situation. In this course, teacher candidates get to know OoSLE and gain a questioning perspective on OoSL by participating in practice activities (Ay et al., 2015). In

addition, the learning and teaching activities that teacher candidates carry out in the classroom will encourage them to engage in out-of-school activities with their students in their teaching lives. This will increase teacher candidates' self-confidence towards OoSL activities. Providing teacher candidates with information about how to carry out OoSL activities will help reduce their concerns about possible problems they may encounter in their planned OoSL activities (Johnson & Chandler, 2009). Considering these situations, it can be stated that OoSLE course in mathematics teaching increases the self-efficacy of teacher candidates. While this finding supports the studies of Gürsoy (2018) and Kayhan Altay & Yetkin Özdemir (2022), it is parallel to Demirel's (2020b) result that the self-efficacy of teacher candidates developed positively after museum education.

The examination of open-ended questions created to determine the effect of the OoSLE course on the perceptions of teacher candidates in mathematics teaching was carried out within the framework of "what OoSLE are", "advantages and disadvantages of OoSLE" and "the teacher's role and contributions to mathematics teaching" for these areas. According to the findings, it was concluded that the OoSL environment that teacher candidates mentioned most before the course was museums. While this finding of the study coincides with the findings of many studies on OoSL (Aydoğdu et al., 2023; Fırat Durdukoca, 2023), it differs from some studies (Ay et al., 2015; Bostan Sarıoğlan & Küçüközer, 2017; Kır et al., 2021; Tatar & Bağrıyanık, 2012). In the studies of Ay et al. (2015) and Kubat (2018), the most frequently mentioned OoSL environment is the science center. In the study conducted, science/art centers were among the OoSLE that teacher candidates stated the most. The reason why the OoSL environment that teacher candidates mentioned most before the lesson was museums may be that they do not have enough knowledge about OoSLE. Because the answers given by teacher candidates about where their OoSLE could be before course are parallel to the out-of-school activities they have carried out before. The majority of teacher candidates who participated in OoSL activities before the course expressed these activities as school trips, museums and pi day activities. The results of the study reveal that the most frequently mentioned places for OoSLE are in this direction. Places such as school gardens, national parks, houses, and planetariums were mentioned less before the lesson. This situation contradicts the fact that the most frequently mentioned OoSL environment in the studies of Bostan Sarıoğlan and Küçüközer (2017) is the "home environment". In Kubat's (2018) study, the planetarium is among the least mentioned places. In this context, the finding supports Kubat's (2018) study.

After the OoSLE course, the majority of teacher candidates stated that "purpose-planned environments" could be used as OoSLE. This shows that teacher candidates are knowledgeable about OoSLE and their self-efficacy towards OoSLE is positive. While places such as historical places, planetariums, parks, and universities were not expressed sufficiently as OoSLE before the course, these places were mentioned more after the course. In addition, it can be seen from the results that the teacher candidates mentioned areas such as recreation areas, virtual classrooms, and botanical gardens that they had not mentioned before, after the lesson, and that they mentioned more places for OoSLE. This situation reveals the effect of the OoSLE course.

The answers given by teacher candidates to the question of where OoSLE can be are consistent with their answers to the question of where OoSLE can be used in mathematics teaching. The OoSLE that can be used in teaching mathematics, which was most frequently mentioned by teacher candidates before the course, is museums, as in the first question. Later, banks, factories/industrial organizations, science and art centers, and trips were seen as OoSLE that could be used in teaching mathematics. This finding differs from Kır et al. (2021) who stated that the most common out-of-school places that can be used in mathematics teaching are the environment-terrain and historical places. After the OoSLE course, almost half of the teacher candidates think that it is possible to teach mathematics wherever there is a connection with the outcome. This is another proof that teacher candidates' self-efficacy for OoSL activities is at a very high level after the course. It is seen that the OoSLE that can be used in teaching mathematics after the course are considerably more than the places mentioned before the course. This shows that teacher candidates have knowledge about OoSLE after the course. When we focus on the learning environments that can be used in teaching mathematics after the course, other than the places mentioned in the first question, places such as planetariums, zoos, public institutions and organizations, technoparks, science festivals, mosques and botanical gardens are mentioned. It is noteworthy that in the answers given, virtual classroom environments are also expressed as learning environments that can be used in mathematics teaching. The activities of Aydoğdu et al. (2022) on the use of virtual classrooms in mathematics education by using virtual museum environments in mathematics lessons support the opinion of the teacher candidates.

Another situation in which the effect of the OoSLE course in mathematics teaching is examined is the opinions of prospective teachers regarding the advantages and disadvantages of OoSLE. Before the course, 40% of the teacher candidates thought that OoSLE provided an

advantage in supporting permanent learning, and this rate increased to 66% after the OoSLE course. In this context, the majority of teacher candidates think that OoSLE will provide advantages in terms of permanent learning. This result overlaps with the findings of Aydoğdu et al. (2023), Bostan Sarıoğlan and Küçüközer (2017) and Kır et al. (2021). In addition, this finding is parallel to Haji et al. (2019)' s idea that examining and solving mathematical problems in areas such as surrounding neighborhoods, libraries, and industrial establishments provides permanent learning. Before the course, attention was drawn to 12 different advantages of OoSLE, such as learning by doing, concretization, relation to real life, and attracting interest/attention. After the course, they expressed 25 different advantages in the context of many situations such as eliminating prejudices against the course, improving communication and social skills, supporting lifelong learning, supporting 21st century skills, and supporting values education. This finding shows the effect of OoSLE course on teacher candidates' thoughts about OoSLE.

Johnson & Chandler (2009) revealed that OoSL activities carried out with teacher candidates are fun, increase interest, and enable association with real life. In a study conducted with science teachers, Çetingüney and Büyük (2022) stated that OoSLE provide permanent learning, active participation, learning by doing and experiencing, and increase interest and motivation. The findings regarding the advantages of OoSLE overlap with the views of Johnson & Chandler (2009) and Çetingüney and Büyük (2022).

According to the findings before and after the course, teacher candidates' most concern about OoSLE is in terms of time. This finding contradicts Fırat Durdukoca's (2023) view that OoSLE save time. Time-related anxiety is also expressed in the studies of Ay et al. (2015), Aydoğdu et al. (2023), Sarıoğlan and Küçüközer (2017), Kubat (2018). Before the course, teacher candidates expressed various difficulties related to OoSLE in terms of administrative (financial difficulties, inability to focus on the subject), pedagogical (unfavorable learning environment, learning that is different from its purpose), guidance (inability to maintain classroom dominance and order) and bureaucratic (permissions, official correspondence) aspects. After the course, the disadvantages stated by the teacher candidates regarding OoSLE include situations such as " it may lead to misconceptions" when a proper plan is not made, "security", "considering the activity only as a trip", "teacher's lack of knowledge about OoSLE". Possible security problems are addressed by Ay et al. (2015), Dillon et al. (2006) and Kubat's (2018) studies. In the Johnson and Chandler (2009) study, approximately 10% of teacher candidates stated that cost could be a disadvantage for OoSLE.

Another situation examined in the study is the role of the teacher in OoSLE. While approximately 68% of teacher candidates emphasized the guiding role of teachers before the course, it was observed that this rate was close to 85% after the course. Teacher candidates are aware that teachers will guide students in OoSLE. The planning role of the teacher in OoSLE after class is also among the notable findings. If teacher candidates or teachers are not given the necessary training or in-service training for OoSLE, their self-efficacy for OoSL activities will not be at a sufficient level. At the same time, it is difficult to achieve the desired goal when the activities to be done before, during and after the activity are not planned correctly for OoSL activities. In this context, planning is important in OoSLE. The main reason why teacher candidates draw attention to the planning role of teachers is thought to be their knowledge of this situation.

Regarding the contribution of OoSLE to mathematics education, teacher candidates think that OoSLE will support permanent learning by concretizing abstract concepts in mathematics teaching. Similar views were found in Kır et al. (2021) study. As the content of mathematics teaching becomes more abstract and less concrete, many students will see mathematics as a discipline that is foreign to them and difficult to understand. In this context, teacher candidates think that OoSLE will contribute to mathematics education by associating mathematics with real life, realizing the function of mathematics in real life, and providing concretization. In the findings obtained, it is also noteworthy that OoSL can contribute to mathematics teaching by improving students' skills such as problem-solving, analytical thinking, critical thinking, communication skills, and taking responsibility. These skills appear as 21st-century skills. Based on these findings, it can be said that the use of OoSLE in mathematics teaching will contribute to the development of students' 21st-century skills.

It was concluded that teacher candidates experienced profound changes in their opinions about OoSLE in mathematics teaching before and after the course and that there was a significant difference between their self-efficacy beliefs in this context. It can be said that the main reason for this result stems from the OoSLE course, as seen in the qualitative findings. It can be said that the activities carried out in the OoSLE course, the introduction of places for OoSL, and the realization of sample application activities prevent teacher candidates' concerns about OoSLE. In this context, it is thought that teacher candidates' self-efficacy increased after the course and they felt empowered towards mathematics education outside of school. In addition, it was concluded in the study that self-efficacy for OoSLE did not differ according to gender. Similarly, Sontay et al. (2017) concluded that science teachers' self-

efficacy beliefs in organizing trips to OoSLE in science teaching did not vary significantly according to gender. Demir and Çetin (2022) also revealed findings that teachers' attitudes towards OoSL activities do not change in the context of the gender variable. In their research with secondary school teachers, Pekin and Bozdoğan (2021) determined that self-efficacy in organizing trips to out-of-school environments did not vary according to gender.

Suggestions

According to the findings, it was determined that teacher candidates were not sufficiently involved in OoSL activities during their student years. In this context, increasing OoSL activities in mathematics courses at primary, secondary and high school levels will enable students to see the place of mathematics in real life by making them realize what mathematics is used in real life.

The study also determined that teacher candidates did not take enough courses on OoSLE during their undergraduate education. Teacher candidates' knowledge of OoSL activities and carrying out OoSL activities within the framework of education may encourage them to engage in OoSL activities with their own students in the future. In this regard, it is recommended to increase the number of courses on OoSL in teacher undergraduate programs in order for teacher candidates to receive more training on OoSLE and activities.

Studies in the literature show that teachers do not receive adequate in-service training for OoSL or are inadequate in OoSL activities (Aydoğdu et al., 2023; Güngör & Göloğlu Demir, 2022; Kır et al., 2021). Thus, teachers should be given in-service training on OoSLE and activities. In addition, teachers should be encouraged to carry out activities outside of school in order to increase their experience in OoSLE.

Economic and bureaucratic difficulties regarding OoSL activities create concern for teachers and teacher candidates. The difficulties experienced by teachers in obtaining the necessary permissions for OoSLE and the financial inadequacy for out-of-school activities prevent them from implementing OoSL in classes. Therefore, support should be provided to solve the economic and bureaucratic problems experienced by teachers regarding OoSL.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No material or moral benefit was provided at any stage of the article. As the author of the research, I declare that I have no declaration of interest/conflict.

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CRediT author statement

The study was conducted by a single author and the entire process was carried out by the corresponding author.

Research involving Human Participants and/or Animals

The study involves human participants. In this study, all the rules specified in the "Directive on Scientific Research and Publication Ethics of Higher Education Institutions" were followed. In this context, it was approved that the research complies with the ethical rules with the decision taken at the meeting of Balıkesir University Science and Engineering Sciences Ethics Committee dated 12.04.2023 and numbered 2023/2 and with the ethics committee permission certificate numbered E-19928322-302.08.01-248055.

Matematik Öğretiminde Okul Dışı Öğrenme Ortamları Dersinin Öğretmen Adaylarının Düşüncelerine Etkisi

Özet:

Bu çalışmada ilköğretim matematik öğretmen adaylarının matematik öğretiminde okul dışı öğrenme ortamları dersi öncesi ve sonrasında okul dışı öğrenme faaliyetlerine yönelik öz yeterlik inançları ve okul dışı öğrenme ortamlarına yönelik düşüncelerinin tespit edilmesi amaçlanmıştır. Amaç doğrultusunda lisans düzeyinde okutulan matematik öğretiminde okul dışı öğrenme ortamları dersinin etkisi incelenmiştir. Çalışmada karma araştırma yöntemi benimsenmiştir. Araştırmanın katılımcıları Türkiye'deki bir devlet üniversitesinde 4. sınıfta öğrenim görmekte olan 59 ilköğretim matematik öğretmen adayından oluşmaktadır. Veri toplama aracı olarak "Okul Dışı Öğrenme Faaliyetlerine Yönelik Öğretmen Öz-Yeterlik İnançları Ölçeği" ve okul dışı öğrenme ortamlarına yönelik altı açık uçlu soru kullanılmıştır. Matematik eğitiminde okul dışı öğrenme ortamları dersinin öğretmen adaylarının öz yeterliklerine ve okul dışı öğrenmeye ilişkin düşüncelerine olumlu etkisi olduğu sonucuna ulaşılmıştır.

Anahtar kelimeler: Matematik öğretimi, okul dışı öğrenme ortamları, öz-yeterlik, ilköğretim matematik öğretmen adayları.

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Research Article

Primary School Students' Cognitive Structures About Nutrient Content: Word Association Test

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Abstract – The study aimed to examine the cognitive structures of primary school students about nutrient content by using a word association test. The case study design, which is a qualitative research method, was used in the study. Participants of the study included 41 fourth grade students in a public school in Bursa in the 2021-2022 academic year. Data were collected by a word association test and analyzed by the content analysis method. The study revealed that 11 themes related to proteins were formed and the most associated sub-theme was the milk, meat, fish, and egg food group. 14 themes were identified for carbohydrates and the most associated sub-theme was the bread and cereals. 13 themes related to fats were created and the most associated sub-theme was the oil seeds. Regarding vitamins 12 themes were created and the most associated sub-theme was the fruits. 13 themes were created for water and 14 themes were created for minerals. While the sub-theme most associated with water was the beverages, the most commonly associated sub-theme for minerals was mineral resources. The students mostly left blank and established wrong relationships was the concept of minerals.

Key words: Nutrient contents, word association test, primary education.

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Introduction

Teaching the concepts correctly and permanently is among the main objectives of science courses. Abstract concepts in science education programs are difficult for students to

understand. These concepts are difficult to understand by students (Ercan et al., 2010). To be able to effectively teach science, it is important to teach the basic concepts contained in it completely and correctly for the trainings to be held in the following years. Because the wrong concepts or misconceptions learned will make subsequent learning quite difficult (Balbağ, 2018).

Proteins, carbohydrates, fats, water, and minerals can be counted among the important concepts within the scope of science course. These concepts both constitute the nutrients that are important for people's healthy diet and are among the concepts that make up the basic components of living things, and it forms the basis of many subjects especially in biology lesson (Sinan et al., 2006).

A healthy diet is very important in every period of life. The habit of healthy eating begins during prenatal development and continues into early adulthood (Gökçay & Garipoğlu, 2002). Especially, the fact that people do not face any health problems when moving from adolescence to adulthood is very related to the healthy eating behaviors acquired during childhood (Charlton et al., 2020). Healthy nutrition is possible with adequate and balanced nutrition. Şanlıer and Yabancı (2005, p.11) describe adequate and balanced nutrition as follows "Even though adequate nutrition generally means providing the necessary energy for the body to live and work, balanced nutrition refers to the consumption of all nutrients as well as energy in regular manner as the body needs". For individuals to have balanced diet, they need to get enough of each food group daily. The 'healthy dinner plate' on the website of the Ministry of Health can be given as an example of how much of each food group we should consume (See Figure 1).

For adequate and balanced nutrition, the food groups listed below should be consumed in the recommended amounts (Ministry of Health, 2023).

- Milk group: This group includes milk and substitutes,
- Meat, egg, and legume group: In this group the food such as meat, chicken, fish, eggs, dried beans, chickpeas, and lentils are found. Oilseeds such as walnuts, hazelnuts, and peanuts are also included in this group,
- Vegetable and fruit group: All edible parts of plants are grouped under the heading of vegetables and fruits,

- Bread and cereals group: This group includes cereal grains such as wheat, rice, corn, rye and oats, as well as flour, bulgur, cracked wheat, cereals, and similar products made from them.

Figure 1 Healthy dinner plate (from Ministry of Health, 2017)

Edible animal and plant tissues are called nutrients, but nutrients are not composed solely of these tissues. Nutrients are composed of organic compounds, inorganic compounds, and water. These substances, which are necessary for our body, are called nutritional elements. Nutritional elements are divided into six groups; proteins, fats, carbohydrates, vitamins, water, and minerals (Baysal, 2007). In science textbooks, the term nutrient contents is used instead of the term nutritional elements (Yaman et al., 2019). These nutrient contents are:

- Proteins: They have constructive and restorative functions in their body. They play a role for people grow in taller, in healing injured people, and in events such as maturation, hair, and nail growth. If we do not get enough protein into our body,

problems such as growth and development decline, weakening of immunity may occur. Proteins can be of animal origin, such as meat, milk, yogurt, eggs, cheese, or vegetable origin, such as lentils, chickpeas, and bulgur. At the same time, peanuts, nuts, etc. it is rich in protein in dried nuts.

- Carbohydrates: People need to walk, sit down, get up, run, etc. We need energy in events. The food group that provides the energy that our body needs is carbohydrates. In cereals and cereal group products, fruits and vegetables, jam, honey, etc. the products are very rich in carbohydrates. We should consume enough of these products at every meal. If we consume too much, it can cause tooth decay and obesity.
- Fats: When people are hungry for a long time, the energy provided by our body from carbohydrates becomes insufficient. In such cases, people get the necessary energy from fats. Too much of it is stored in the body and causes weight gain. For creatures living in cold regions, body fat is used to keep body temperature warm. Vegetable oils are mostly found in olives, sunflower, walnuts, hazelnuts, sesame, and corn. Butter and tail fat can be given as an animal product example.
- Vitamins: They serve in the regular functioning of our organs in our body. They protect us against diseases by providing body resistance. Vitamins are especially abundant in fruits and vegetables. We need to consume enough fruits and vegetables every day. If we do not consume enough, body resistance decreases, and we get sick.
- Water and minerals: Our bodies need water. People meet these needs with food and drinks. All the food we eat contains water. Minerals are found in many foods, as well as in water and soil. Salts in rock are affected by environmental influences (wind, temperature, rain, etc.) And it mixes into the soil by crumbling, plants take up the minerals contained in the soil with their roots. Animals eat plants to feed and, thus get minerals into their body. They act as regulators in people's body.

When 1st, 2nd, and 3rd grade programs of the Life Science (LS) course in the 2021-2022 academic year are examined, the "Healthy Life" unit includes the achievements related to health and balanced nutrition (Ministry of National Education [MoNE], 2018):

- 1st grade objectives included in the classroom Life Science Course Curriculum are the following: LS. 1.3.2., LS. 1.3.3., LS. 1.3.4., and LS. 1.3.6.
- 2nd grade objectives included in the classroom Life Science Course Curriculum are the following: LS. 2.3.1., LS. 2.3.2., and LS. 2.3.6.

- 3rd grade objectives included in the classroom Life Science Course Curriculum are the following: LS. 3.3.2., LS. 3.3.3., LS. 3.3.4. and LS. 3.6.2.

When we examine the curriculum of the 4th grade Science (S) course curriculum, "Our Nutrients / Living Things and Life" includes the following objectives related to healthy nutrition and nutrient content (MoNE, 2018):

- 4th the grade objectives included in the classroom Science Course Curriculum are following: S. 4.2.1.1., S. 4.2.1.2., S. 4.2.1.3. and S. 4.2.1.4.

Within the scope of the Physical Education and Sports lesson program, there are objectives of balanced nutrition in the 5th grade objectives, objectives of preparing a nutrition program in the 7th grade objectives, and objectives of being a conscious consumer in food and beverage choices in the 8th grade objectives.

The objectives of protein, carbohydrate, fat, vitamin, water, and mineral in the 9th grade Biology (B) Curriculum:

- The objectives of B. 9.1.2.1. and B. 9.1.2.2. in the 9th grade related to the topic called "Basic compounds found in the structure of living things" in the "Life Science Biology" unit (MoNE, 2018).

In the study of Sakar and Açkurt (2019) named nutrition habits and nutritional knowledge status of teachers working in primary schools, they found that the subjects in the primary school curriculum of the teachers were insufficient in terms of nutrition education. In the study titled investigation of eating behaviors of second level primary school students conducted by Gün (2020), it was revealed that eating behaviors of the students participating in the study were at a low level. In the study of Şimşek et al. (2009) titled evaluation of lunchboxes of school-age children, it was found that students consume unhealthy foods more than healthier foods. Kösedag (2019) determined that the students had insufficient and unbalanced nutrition in her study titled examination of the contents of lunchboxes of primary school students.

When all these were considered, the concepts related to nutrient contents were among the important concepts we encounter throughout our education and training lives. In addition, nutrient content is among the concepts that lay the foundation for our adequate and balanced nutrition habits that will affect our lives.

Constructivist learning approaches have been used in recent years to explain these concepts to students in a more understandable way and to increase memorability. For meaningful learning to take place in the constructivist approach, the student reaches new knowledge and builds his cognitive structure by establishing a relationship with previous learning or experiences and builds his new knowledge on top of his existing knowledge (Arslan, 2007). In parallel with the use of the constructivist approach in education, traditional assessment and evaluation techniques have been replaced with alternative assessment and evaluation techniques.

Particularly, in the primary education program, which was renewed in 2005, attention was drawn to alternative measurement and evaluation techniques and suggestions which were made for their implementation (MoNE, 2005). Alternative measurement tools were aimed at measuring not only the cognitive behavior of students but also their psychomotor and affective behavior, in addition to traditional measurement tools. Among these measurement tools, rubric, attitude scales, structural grid testing, concept maps, and performance evaluation, etc. are used. One of these techniques is the word association test (WAT) (Kayhan, 2019).

WAT is among the most common used methods. In the word association test, the student's cognitive structure related to the subject, the connection between the concepts related to the subject and the level or significance of the relationship between the concepts in the long-term memory related to the subject were determined. In this method, students were given a certain amount of time according to their grade level and they were asked to write down which concepts / words they evoke first in their minds against the given key concept / word (Bahar & Özatlı, 2003). Among the purposes of using word association tests were detecting students' misconception and conceptual changes and revealing their cognitive structures can be counted (Işıklı et al., 2011).

According to literature review, there are some studies measuring the structures of the basic components of living things by using the WAT of the high school students (Bahar & Özatlı, 2003). However, no study has been found that aims to measure the cognitive structures of primary school students using word association test. In this current study, using word association test to determine the cognitive structures of the students regarding the nutrient content concepts in the "Our Nutrients / Living Things and Life" unit the primary school 4th grade science curriculum intended. The sub-problems of the research are as follows:

1. What are the cognitive structures of primary school students related to the concept of proteins?

2. What are the cognitive structures of primary school students related to the concept of carbohydrates?

3. What are the cognitive structures of primary school students related to the concept of fats?

4. What are the cognitive structures of primary school students related to the concept of vitamins?

5. What are the cognitive structures of primary school students related to the concept of water?

6. What are the cognitive structures of primary school students related to the concept of minerals?

Method

Research Model

In this study a case study design, which was one of the qualitative research methods, was used. Case studies are a type of research in which one or more events, groups, systems, and programs that are related to each other are examined in depth. Generally, it aims to explain and evaluate one or more situations within its own boundaries (Büyüköztürk et al., 2016).

Participants

Participants of the study included 41 fourth grade students from two different classes of a public school in Bursa in the 2021-2022 academic year. Sample was chosen by criterion sampling method. Criterion sampling method, which was one of the non-random sampling methods was used in the study (Büyüköztürk et al., 2016). Nutrient concepts were taught in the unit of "Our Food / Living Things and Life" in the 4th grade Science curriculum. Therefore, 4th grade students were chosen as a sample of the study.

Data Collection Tools

The word association test was used as a data collection tool in the study. WAT revealed that how the students made relationships between the concepts related to nutrient content. It helped to determine whether these relationships were significant or whether they were

sufficient. By using this technique, relevant and important concepts were selected, with at least five and at most ten concepts (Gündoğan & Gültekin, 2018). Each of the key concepts used in the word association test was prepared on one page. At the same time, the students participating in the study were asked to fill in the relevant sentence under key concepts. In this way, students were provided to establish a relationship with concepts (Bahar & Özatlı, 2003; Deveci et al., 2014).

To prepare the word association test in the study, the concepts of nutrient contents in the unit of "Our Food / Living Things and Life" in the 4th grade Science curriculum were included. These concepts were proteins, carbohydrates, fats, vitamins, water, and minerals. There were two main reasons for choosing these concepts. One of the reasons to choose these topics was, these concepts were asked to four classroom teachers working in a public school with the following question: 'Which subject do students have the most difficulty in understanding within the scope of science subject?' As a result of the unstructured interviews with the teachers, they reported that their students had the most difficulty in understanding the concepts of proteins and minerals. They mentioned that the students mixed the concepts of vegetable proteins with carbohydrates. The second reason to choose these topics was importance of the concepts of nutrient content within the scope of science course. The answers of the students to the concepts / words in the word association test about nutrient contents will also reveal their knowledge about proper nutrition. A sample of the form used in the study was given Figure 2.

Proteins: …….
Proteins: …….
Proteins: …….
Proteins: …….
Proteins: …….
Related Sentence:

Figure 2 A sample of the form used in the study

In this study, the WAT was applied to the students after the nutrient concepts had been instructed by traditional methods. First the students were given some information about the implementation of WAT. Then, they were asked to write down the first concepts / words that came to their minds for each concept respectively and fill in the related sentence part. 90 seconds were given to write each concept and related sentence in the test. After the given time was over, they move on to the next concept and the same time was applied for each new

concept. When the studies on the subject were examined, it was determined that this period may differ according to the grade levels (Kaya & Taşdere, 2016).

Data Analysis

The collected data of WAT have been analyzed by content analysis method. In this method, the aim was to identify the concepts / words that can explain the data and to determine their relationship with each other. Therefore, concepts that were related to each other or similar were collected and interpreted under the same category (Ekici & Kurt, 2014). Content analysis usually includes frequency and percentage tables that present the current situation.

The word association test used as the data collection tool was made ready for analysis. The data collected in the research were first transcribed and codes were created for the purpose. These generated codes were collected under the appropriate categories or themes (Ültay et al., 2021).

Themes, sub-themes, and frequency values were determined for each concept and frequency tables have been created in accordance with findings obtained by examining which words were written for the concepts given in the WAT (Kaya & Akış, 2015). To determine the validity of the study, the data were coded by the lecturers working in the department of biology education and validity percentages of the study were calculated using the formula proposed by Miles and Huberman (1994). Reliability: (Number of codes with a match) / (Total number of codes with and without a match) x 100. Reliability coefficient was found as %88.

Results

Results Related to the Concept of Proteins

11 themes were created related to students' cognitive structures about proteins. Themes, the sub-themes, and frequencies were presented in Table 1.

Table 1 Themes and sub-themes related to the concept of proteins

Themes	Sub-themes	*f*
Milk, Meat, Fish, Eggs Food Groups (111)	Meat, Steak, Doner, Meatball, Cutlet	30
	Egg	23
	Fish	16
	Milk	16
	Chicken	13
	Cheese	9
	Yoghurt, Buttermilk	4
Fruit (7)	Fruit	5
	Banana	1
	Kiwi	1
Vegetable (8)	Vegetable	5
	Pea	1
	Spinach	1
	Salad	1
Oil Seeds (9)	Hazelnut	3
	Peanut	2
	Almond	1
	Walnut	1
	Dried nuts	1
	Olive	1
Function (5)	Energy, Power	3
	Repair	2
Importance (12)	Health	5
	Sport	2
	Bone	2
	Benefit	1
	Illness	1
	Muscle	1
Foods High in Sugar (1)	Honey	1
Fats (5)	Olive oil	3
	Oil	2
Vitamin (2)	Vitamin	2
Water (1)	Water	1
Other (10)	Protein powder	4
	Nutrition	3
	Food	2
	Soup	1
Total	37	171

As seen in Table 1, six out of 41 students left this part blank. The total number of words obtained from all themes was 171. The words were mostly in the theme of milk, meat, fish, eggs food groups (111). The most frequently mentioned concepts under this theme are: Meat, steak, doner, meatballs, cutlets (30), eggs (23), fish (16), and milk (16). Respectively, it was followed by the themes of importance (12), other (10), and oilseeds (9). The most commonly written concept under the theme of its importance was health (5). The concept that was written the most under the theme of other, which comes in third place, was protein powder (4). Finally, the most frequently written concept under the theme of oilseeds was hazelnut (3).

While the students mostly associated the concept of proteins with animal protein sources, they did not make sufficient associations with other protein sources such as vegetable protein sources and oil seeds.

When the data obtained from the sentence analyses related to the concept of proteins were evaluated, the total number of sentences was 36 since five out of 41 students left the sentence part empty. The 36 sentences obtained were divided into three main categories: Informational sentences (12), related sentences (18), and unrelated sentences (6).

- Examples of informational sentences:

"Protein helps our bones to develop."

"It helps heal my wounds."

"Meat, milk and chicken contain plenty of protein."

- Examples of related sentences:

"We'll have meat tonight."

"I like to drink milk."

"The meat is very good."

- Examples of unrelated sentences:

"I wrote protein with my pen."

"I like sports ."

"I drank vitamins."

Results Related to the Concept of Carbohydrates

14 themes related to carbohydrates were formed, and the sub-themes and frequencies of each theme were presented in Table 2.

Table 2 Themes and sub-themes related to the concept of carbohydrates

Themes	Sub-themes	*f*
Foods High in Sugar (12)	Jam	3
	Cake	2
	Honey	2
	Molasses	1
	Sugar	1
	Chocolate	1
	Jellybean	1
	Wafer	1
Bread and Cereal Group (82)	Bread	21
	Pasta	17
	Rice, Pilaf	13
	Bulgur	7
	Wheat	6
	Cake, Cookie	5
	Cereal	4
	Barley, Rice	3
	Toast	2
	Flour	2
	Pastry	1
	Biscuit	1
Fruit (3)	Fruit	2
	Apple	1
Vegetable (8)	Fresh beans	3
	Vegetable	3
	Potato	1
	Okra	1
Form (1)	Solid	1
Function (10)	Energy, Power	10
Importance (7)	Vigorous	2
	Need	1
	Health	1
	Run	1
	Tiredness	1
	Sleep	1
Milk, Meat, Fish, Eggs Food Groups (7)	Sausage	3
	Meat	1
	Fish	1
	Egg	1
	Animal origin	1
Oil Seeds (9)	Hazelnut	3
	Snack	2
	Peanut	2
	Walnut	1
	Sunflower seed	1
Fats (2)	Oil	2
Water (1)	Water	1
Salt (1)	Salt	1
Other (4)	Food	2
	Junk food	1
	Frying	1
Unrelated (1)	Brain	1
Total	51	148

According to Table 2, 10 out of 41 students did not write any sentence. The total number of words obtained from all themes was 148. They were mostly gathered in the theme of the bread and cereal group (82). The most frequently written concepts in this theme were bread (21), pasta (17), pilaf, and rice (13). Respectively, the bread and cereals group were followed by foods high in sugar (12) and function (10). While the most frequently written concept in the theme of foods containing high sugar was jams (3), the most frequently written concept in the theme of function was energy and power (10). The students mostly associated the concept of carbohydrates with bread and cereal group carbohydrate sources and did not make sufficient associations with other carbohydrate sources such as fruits and vegetables and sugars. Based on the function theme in the third place, we can say that the students have detailed knowledge about the concept of carbohydrate.

In addition, according to the results of the analysis of the sentences related to the concept of carbohydrates, the total number of sentences was 33 and eight people left the sentence of carbohydrates empty. The 33 sentences were divided into three main categories: Informational sentences (14), related sentences (12), and unrelated sentences (7).

- Examples of informational sentences:

"It gives us energy."

"We must eat to store energy."

"We need energy while running, and carbohydrates provide it."

- Examples of related sentences:

"I ate bread today."

"I eat carbohydrates every day."

"I'm going to buy bread."

- Examples of unrelated sentences:

"I like to eat."

"I ate eggs for breakfast today ."

"I ate junk food."

Results Related to The Concept of Fats

13 themes related to fats were created in the cognitive structures of the students participating in the research by using WAT, and the sub-themes and frequencies of each theme were presented in Table 3.

Table 3 Themes and sub-themes related to the concept of fats

Themes	Sub-themes	*f*
Animal Fats (17)	Butter	13
	Margarine	2
	Animal fats	2
Vegetable Oils (26)	Olive oil	12
	Liquid oil	6
	Flower oil	6
	Corn oil	1
	Vegetable oil	1
Oil Seeds (32)	Hazelnut	9
	Dried nut	7
	Walnut	6
	Peanut	4
	Cashew	2
	Almond	2
	Pistachios	1
	Groundnut	1
Vegetables (12)	Potato	5
	Salad	4
	Celery	1
	Lettuce	1
	Onion	1
Foods High in Sugar (16)	Chocolate	7
	Sugar	5
	Carbohydrate	2
	Jellybean	1
	Ice cream	1
Bread and Cereal Group (9)	Biscuit	3
	Pasta	2
	Bagel	1
	Pancake	1
	Toast	1
	Cracker	1
Foods High in Fat (8)	Chips	5
	Frying	3
Milk, Meat, Fish, Eggs Food Groups (13)	Meat	5
	Yogurt	2
	Milk	2
	Fish	1
	Chicken	1
	Cheese	1
	Sausage	1
Color (1)	Yellow	1
Function (4)	Energy	4
Importance (11)	Weight	4
	Expensive	2
	Increment	1
	Obesity	1
	Weaken	1
	Body fat	1
	Damage	1
Other (1)	Soup	1

Unrelated (3)	Rain	2
	Brain	1
Total	53	153

As seen in Table 3, nine out of 41 students did not give any answer for this part. The total number of words obtained from the themes was 153. The words mostly grouped in the theme of oil seeds (32). The most common concepts in the theme of oil seeds were hazelnut (9), dried nuts (7), and walnut (6). Respectively, this theme was followed by the themes of vegetable oils (26) and animal fats (17). While olive oil (12) was the most common concept in the theme of vegetable oils, butter (13) was the most common concept in the theme of animal fats. The students mostly associated the concept of fats with the themes of oil seeds, vegetable oils and animal fats, that was, with the types of fats.

According to the results obtained from the sentence analysis related to the concept of fats, it was determined that the total number of sentences was 33. Eight out of 41 students have left the related sentence blank. The 33 sentences obtained were divided into three main categories. These three main categories were: Informational sentences (12), related sentences (14), and unrelated sentences (7).

- Examples of informational sentences:

"We should not consume too much fat, because we gain weight."

"It is one of the sources of energy."

"Found in dried nuts."

- Examples of related sentences:

"I used sunflower oil when I cooked."

"Olive oil is very good."

"I try not to eat fatty things."

- Examples of unrelated sentences:

"I went to get food."

"I only ate one of the prizes."

"I ate a lot of pasta."

Results Related to The Concept of Vitamins

Using the WAT for nutrient contents, 12 themes related to vitamins were formed in the students' cognitive structures. The sub-themes and frequencies of each theme were given in Table 4.

Table 4 Themes and sub-themes related to the concept of vitamins

Themes	Sub-themes	*f*
Fruits (78)	Orange	18
	Fruit	14
	Apple	11
	Strawberry	6
	Banana	5
	Watermelon	4
	Cherry	3
	Lemon	3
	Peach	3
	Cucumber	3
	Pineapple	2
	Tomato	2
	Pear	1
	Plum	1
	Apricot	1
	Kiwi	1
Vegetables (21)	Vegetable	10
	Carrot	6
	Radish	1
	Greenery	1
	Cabbage	1
	Leek	1
	Broccoli	1
Varieties (9)	Vitamin C	4
	Vitamin D	3
	Vitamin A	2
Milk, Meat, Fish, Eggs Food Groups (3)	Cheese	2
	Fish	1
Oil Seeds (2)	Walnut	1
	Almond	1
Foods High in Sugar (1)	Molasses	1
Bread and Cereal Group (1)	Pasta	1
Water (4)	Water	4
Minerals (2)	Calcium	1
	Iron	1
Function (6)	Energy, Power	6
Importance (16)	Health	10
	Medicine	4
	Doctor	1
	Sun	1
Unrelated (2)	Plastic	1
	Wood	1
Total	42	145

According to Table 4, seven out of 41 students left this section blank. The total number of words obtained from the themes was 145. The words were mostly collected in the theme of fruits (78). The concepts in this theme were collected most often in orange (18), fruit (14), and apple (11). Although orange (18) was the most frequently written concept in the fruit theme, the number of lemons (3) was quite low. Later, the themes of vegetables (21) and importance

(16) followed the theme of fruits. While the most common concepts in the theme of vegetables were vegetables (10) and carrot (6), the most common concept in the concept of importance was health (16). The students mostly associated the concept of vitamins with the theme of fruits. The students mostly constructed the key concept of vitamins correctly in their minds. However, the energy sub-theme in the function theme reveals that some of the students in the study associate vitamins with energizing nutrients. This association was not a correct one.

When the sentences related to the concept of vitamins were analyzed, it was determined that the total number of sentences was 33. It was observed that eight out of 41 students left the sentence blank. The 33 sentences were divided into three main categories. These three main categories were: Informational sentences (13), related sentences (17), and unrelated sentences (3).

- Examples of informational sentences:

"Fruits and vegetables contain lots of vitamins."

"It heals us when we are sick."

"It keeps us healthy."

- Examples of related sentences:

"I had an orange for lunch today."

"We drink orange juice for breakfast."

"We bought carrots from the market."

- Examples of unrelated sentences:

"I do not know."

"I ate it for breakfast."

"I drank."

Results Related to The Concept of Water

Using the WAT related to the nutrient content of the students, 13 themes related to water were formed in their cognitive structures and the sub-themes and frequencies of each theme were given in Table 5.

Table 5 Themes and sub-themes related to the concept of water

Themes	Sub-themes	*f*
Beverages (64)	Orange juice, Apple juice, Pomegranate juice, Lemonade	22
	Fruit juice	15
	Carbonated drinks	9

	Buttermilk	7
	Milk	5
	Soap	2
	Tea	1
	Mineral water	1
	Milkshake	1
	Erikli (Trademark)	1
Fruits (6)	Watermelon	2
	Tomatoes	1
	Fruit	1
	Melon	1
	Mandarin	1
Vegetables (2)	Vegetable	2
State in Nature (22)	Snow	8
	Rain	8
	Liquid	4
	Ice	2
Water Resources (10)	Sea	5
	Lake	2
	Dam	1
	Mountain	1
	Forest	1
Proteins (3)	Fish	2
	Meat	1
Foods High in Sugar (2)	Chocolate	1
	Molasses	1
Fats (2)	Fat	2
Vitamins (3)	Vitamin	3
Minerals(5)	Minerals	5
Related Items (11)	Bottle	3
	Water bottle	2
	Cup	2
	Fountain	2
	Glass	1
	Cologne	1
Function (9)	Health	6
	Regulator	1
	Balance	1
	Energy	1
Importance (27)	Live, Life	10
	Plant, Tree	3
	Dirt	2
	Bathroom	2
	Drought	2
	Bill	1
	Waste	1
	Fresh air	1
	Soil	1
	Fire	1
	Need	1
	Medicine	1
	Happiness	1
Total	55	166

As in Table 5, five out of 41 students left the related part blank. The total number of words obtained from the themes was 166. The words were mostly collected in the theme of beverages (64). The concepts in this theme were collected most often in orange juice, apple juice, pomegranate juice, and lemonade (22), fruit juice (15), and carbonated drinks (11). The themes of importance (27), and state in nature (22) followed the theme of beverages, respectively. While the most common concept in the theme of importance was live, life (10), the most common concepts in the theme of state in nature were snow (8) and rain (8). The students associated the key concept of water with beverages. Furthermore, it could be said that the students made the right conclusions about the importance of water in our lives and its physical properties. However, the energy sub-theme found in the theme of function was not a correct association with the concept of water.

When the sentences related to the concept of water were analyzed, it was observed that the total number of sentences was 34 and seven students left this part blank. The 34 sentences were divided into three main categories. These three main categories were informational sentences (16), related sentences (16), and unrelated sentences (2).

- Examples of informational sentences:

"They act as regulators in our body."

"Water is a basic need."

"Our bodies have plenty of water and human beings need water."

- Examples of related sentences:

"I took juice to school today."

"I drink a lot of water."

"Dams filled with water."

- Examples of unrelated sentences:

"Mom made meatballs today."

"I play sports."

Results Related to The Concept of Minerals

14 themes related to minerals were formed in their cognitive structures and the sub-themes and frequencies of each theme were given in Table 6.

Table 6 Themes and sub-themes related to the concept of minerals

Themes	Sub-themes	*f*
Mineral Resources (29)	Pebble stone	11
	Rock	6
	Mine	6
	Coal	2
	Fossils	1
	Soil	1
	Earth crust	1
	Brick	1
Fruits (25)	Orange	7
	Apple	5
	Mandarin	3
	Strawberry	3
	Watermelon	2
	Melon	2
	Pear	1
	Lemon	1
	Banana	1
Vegetables (4)	Lettuce	2
	Carrot	1
	Eggplant	1
Milk, Meat, Fish, Eggs Food Groups (12)	Milk	4
	Red meat	2
	White meat	2
	Egg	2
	Fish	1
	Protein	1
Foods High in Sugar (5)	Molasses	4
	Jam	1
Bread and Cereals Group (3)	Wheat	1
	Pasta	1
	Rice	1
Mineral Varieties (6)	Gold	3
	Copper	2
	Iron	1
Beverages (18)	Plain soda	7
	Carbonated drink	6
	Bubble	2
	Acid	1
	pH	1
	Tea	1
Function (8)	Regulator	4
	Energy, Power	4
Importance (8)	Microbe	3
	Health	3
	Life, Breath	2
Vitamin (1)	Vitamin	1
Water (18)	Water	18
Other (1)	Soap	1
Unrelated (5)	Air, Exhalation, Cloud, Sky	5
Total	49	143

As seen in Table 6, 12 out of 41 students did not write any sentence for minerals. The total number of words obtained from the themes was 143. The students' responses were mostly picked in the theme of mineral resources (29). The concepts in this theme were collected most often in pebble stone (11), rock (6), and mine (6). The themes of fruits (25), beverages (18), and water (18) followed the theme of mineral resources, respectively. The most frequently associated concepts in the fruit theme were orange (7) and apple (5), the concept most associated with the theme of beverages is plain soda (7) and carbonated drink (6), the concept most associated with the theme of water was water (18).

The students mostly associated the mineral key concept with mineral sources and fruits. The sub-themes of energy and power in the theme of function determine that students make an incorrect association in their cognitive structures about minerals. This result revealed that the concept of minerals was comprehended superficially by the students. Furthermore, among all the concepts analyzed for nutrient content, it was the concept with the most unrelated contact.

As a result of the sentence analysis related to the concept of minerals, the total number of sentences was 29. This number was the lowest among sentences containing other key concepts. 12 out of 41 students left the related sentence empty. The 29 sentences were divided into 3 main categories. These three main categories were informational sentences (12), related sentences (5), and unrelated sentences (12). The number of unrelated sentences was found to be quite high compared to other key concepts.

- Examples of informational sentences:

"Minerals are found in rocks."

"Minerals act as regulators."

"The difference of stones depends on the minerals in their structure."

- Examples of related sentences:

"It is found in almost every food."

"We found a fossil."

"Minerals are good for our body."

"Minerals are very important."

- Examples of unrelated sentences:

"We love it as a family."

"Water and soup are liquid."

"We should not pollute the air."

"I formed the word mineral with a sentence."

As a result, total frequencies of the themes and sub-themes of keywords including nutrient content were given in Table 7.

Table 7 Total themes and sub-themes of keywords related to nutrient content

Key Concepts	Total Themes *f*	Total Sub-themes *f*
Proteins	37	171
Carbohydrates	51	148
Fats	53	153
Vitamins	42	145
Water	55	166
Minerals	49	143

According to Table 7, the concept with the highest number of themes among the given key concepts was water (55), fats (53), and carbohydrates (51). The key concept with the highest number of words obtained from the themes was proteins (171). This was followed by water (166) in second place and fats (153) in third place.

The frequencies of the themes and sub-themes of the students' sentences related to nutrient contents were given in Table 8.

Table 8 Total themes and sub-themes related to the sentences about nutrient content

Themes	Total *f*	Sub-themes	Total *f*
Proteins	36	Informational sentences	12
		Related sentences	18
		Unrelated sentences	6
		No answer	5
Carbohydrates	33	Informational sentences	14
		Related sentences	12
		Unrelated sentences	7
		No answer	8
Fats	33	Informational sentences	12
		Related sentences	14
		Unrelated sentences	7
		No answer	8
Vitamins	33	Informational sentences	13
		Related sentences	17
		Unrelated sentences	3
		No answer	8
Water	34	Informational sentences	16
		Related sentences	16
		Unrelated sentences	2
		No answer	7
Minerals	29	Informational sentences	12
		Related sentences	5
		Unrelated sentences	12
		No answer	12

As seen in Table 8, the students wrote related sentences about proteins (18), water (16), and fats (14) respectively. While proteins (5) were the least frequently left empty, minerals (12) were the most frequently left empty among all key concepts. Moreover, the students wrote unrelated sentences about minerals at most.

Conclusions and Suggestions

In this study, a word association test was conducted to reveal the cognitive structures of fourth grade primary school students about nutrient content. The number of words and the number of words produced for the key concepts in the word association test applied in the study was one of the techniques used to evaluate the data. The quality and frequency of the words in response to key concepts can be used to determine whether the topic has been understood. A key concept that is not associated with any concept or word does not make any sense for the students (Çardak, 2009).

Concepts related to healthy and balanced nutrition, nutrition, and nutrient content were encountered by students especially in primary school. There were 14 learning outcomes related to this subject in the primary school curriculum within the scope of life science and science courses. In addition, in the 4th grade, there was a separate unit on the subject called 'Our Food / Living Things and Life'. Concepts and achievements related to the subject continue to be encountered in middle and high school periods. Similarly, Follong et al. (2022) examined the nutrition programs of primary schools and found that nutrition education topics were generally related to food groups.

In the study, the following concepts were examined in the word association test: Proteins, carbohydrates, fats, vitamins, water, and minerals. In addition, students were asked to write sentences about each key concept.

Among the key concepts given, the concept with the highest number of themes was water, fats, and carbohydrates. These were followed by minerals, vitamins, and proteins. The key concept with the highest number of words was proteins. This was followed by water, fats, carbohydrates, vitamins, and minerals.

In the study, the highest number of words was related to the concept of proteins with 171. In addition, proteins were the concept with the highest number of sentences in the related sentence section with 36 sentences. Similarly, in the study of Yurtbakan et al. (2021) about organic and non-organic foods for 4th grade primary school students, the word protein ranked first among the answers given by the students in the pre-WAT related to nutrients. As a sub-

theme in the concept of proteins, the food group of milk, meat, fish, eggs food groups sources ranked first with 111 words. This result proved that the students associated proteins mostly with animal proteins and their cognitive structures about other protein sources were weak. Therefore, teachers should emphasize the importance of other protein sources by using different teaching methods and techniques, especially when explaining protein sources. Vegetable protein sources are both more easily accessible and contain fewer harmful components than the animal protein sources (Çetiner & Ersus Bilek, 2018).

The second key concept with the highest number of words produced was the concept of water with 166 words. There were two prominent sub-themes related to the key concept of water: Beverages and importance. In the word association test study of Bahar and Özatlı (2003), the cognitive structures of high school 1st grade students about the basic components of living things were investigated. In this study, the words life, need and beverage came to the fore like the key concept of water. In the study by Young et al. (2021), both the importance of water in nutrition and its importance in our lives were mentioned. When the results obtained in the theme of beverages were examined, it was found that the students associated water with fruit juice the most and only one student associated it with drinking water. This result was quite remarkable. A future study can be conducted on this issue. Another concept in the beverages theme was milk. Milk is a strong source of protein (Ünal & Besler, 2008). Another important result was that some students associated water with milk. Although one person wrote the concept of energy under the theme of function, water was not among the energizing nutrients (Ünsal, 2019). Furthermore, a total of 34 sentences related to the key concept of water were formed. It was the second concept with the highest number of sentences among the given key concepts.

Then there were fats with 153 words. In the concept of fats, the most association was made with the theme of oil seeds. It was later associated with vegetable oils and animal fats. The students made stronger associations with vegetable fats than with animal fats. They mostly associated the concept of oil with the theme of oil types. Generally, it can be said that the cognitive structures of students related to fats are strong. A total of 33 sentences were formed about the concept of fats.

There were 148 words in the concept of carbohydrates. In this concept, the answers given by the students in the bread and cereal group theme were also found intensely. Although fruits and vegetables are an important source of carbohydrates, a weak relationship was established between them by the students. The reason for this can be investigated by

different methods such as survey or interview. It is recommended that teachers explain carbohydrate sources in a more memorable way with different methods. Similarly, in the study conducted by Çelik Kayapınar and Aydemir (2014), 42 percent of the high school students participating in the study related their carbohydrate sources to cereals. A total of 33 sentences were formed about the concept of carbohydrates.

145 words related to the key concept of vitamins were created. The concept of vitamins was most associated with fruits. Gündoğdu (2018) examined the misconceptions about organic molecules in biology course in a study conducted with 9th grade high school students. As a result of the study, it was determined that students did not perceive vitamins concretely very much and therefore they usually made connections with fruits. Although the concept of orange, which was included in the theme of fruits, was written by many students, lemon was written quite few. Orange and lemon are words that are usually used together in everyday life and have associations with each other. In addition, the students associated the theme of vegetables with vitamins less than the theme of fruits. Vitamin C is especially abundant in oranges, lemons, green vegetables, tomatoes, cauliflower, cabbage, broccoli (Dalkılıç, 2020). Energy written under the theme of functions by the students was among the misconceptions about vitamins since vitamins were not recognized as energy-giving nutrients in our bodies (Şahin, 2018). All these results show that students lack knowledge about vitamins. The concept of vitamin can be explained with different teaching methods and techniques and studies can be carried out to eliminate the lack of knowledge in students. There were 33 sentences about vitamins, just like carbohydrates and fats.

There were 143 words related to the key concept of minerals. The weakest key concept in which students' cognitive structures was minerals. In the word association test, it was both the key concept that students formed the fewest number of sentences with 29 and the key concept that was left blank the most with 12 students leaving it blank. It was highly associated with the theme of fruits, which suggests that the concept of minerals was not fully understood. Therefore, additional learning can be done, particularly regarding the key concept of minerals.

The students associated the key concept of water, vitamins, and minerals with energy in the theme of function in line with their answers. This result indicated that the students did not have enough information about the function of water, vitamins, and minerals. Similarly, the study of Şahin (2018) related to misconceptions about nutrients in middle school students concluded that vitamins, water, and minerals were characterized as nutrients that provide

energy. There was a lack of knowledge about energizing foods among the students. It is recommended that teachers do additional learning with students, especially about energizing foods.

In this study another concept that was associated with the concept of mineral in high numbers was water. The reason for this may be that the students have studied the concept of water and mineral under the same title in the national education textbook (Yaman et al., 2019). However, mineral was quite rare among the students' answers related to the concept of water. The reason for this result can be investigated in other studies too.

Depending on the results of the current study, in future studies

- the WAT technique can be used to identify students' cognitive structures and misconceptions about other basic concepts in science,
- the quantity of people in working groups can be more,
- the development of students' cognitive structures related to the subject can be determined by applying pretest and posttest,
- students' cognitive structures related to nutrient content can also be measured with techniques such as surveys and interviews.

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Research involving Human Participants and/or Animals

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İlkokul Öğrencilerinin Besin İçeriklerine İlişkin Bilişsel Yapıları: Kelime İlişkilendirme Testi

Özet:

Çalışmanın amacı, ilkokul dördüncü sınıf öğrencilerinin besin içeriklerine yönelik bilişsel yapılarını belirlemektir. Çalışmada, nitel araştırma yöntemlerinden durum çalışması desenini kullanılmıştır. Çalışma grubu, 2021-2022 eğitim-öğretim yılı Bursa'da bir devlet okulundaki 41 dördüncü sınıf öğrencinden oluşmaktadır. Veriler, kelime ilişkilendirme testi kullanılarak toplanmıştır. Verilerin analizinde içerik analizi yöntemi kullanılmıştır. Çalışma sonuçlarına göre, proteinlerle ilgili 11 tema oluşturulmuş ve en çok ilişkilendirilen alt tema süt, et, balık ve yumurta besin grubudur. Karbonhidratlarla ilgili 14 tema oluşturulmuş ve en çok ilişkilendirilen alt tema ekmek ve tahıl grubudur. Yağlarla ilgili 13 tema oluşturulmuş ve en çok ilişkilendirilen alt tema yağlı tohumlardır. Vitaminlerle ilgili ise 12 tema oluşturulmuş ve en çok ilişkilendirilen alt tema meyvelerdir. Su ve minerallerle ilgili sırasıyla 13 ve 14 tema oluşturulmuştur. Suyla en çok ilişkilendirilen alt tema içeceklerken, minerallerle ilişkilendirilen alt tema mineral kaynaklarıdır. Öğrencilerin en fazla boş bıraktıkları ve yanlış ilişkiler kurdukları kavram ise minerallerdir.

Anahtar kelimeler: Besin içerikleri, kelime ilişkilendirme testi, ilköğretim.

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Research Article

Examination of Preschool Teachers' Views on Mathematics Efficacy

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Abstract – This study aims to examine preschool teachers' views on mathematics self-efficacy, mathematics teaching self-efficacy, and factors affecting mathematics efficacy. The study was conducted with 10 preschool teachers working at public schools in a province (Mersin) in the Mediterranean Region of Turkey in the 2022-2023 academic year. In the study where case study was adopted, the participants were teachers from different school types and with different professional experiences. The results of the study revealed that preschool teachers consider mathematics efficacy in the context of mathematics self-efficacy and mathematics teaching self-efficacy. However, they stated that internal and external factors were effective on mathematics efficacy. In addition, different parameters played a role in whether they found themselves competent in mathematics efficacy. Depending on the results of the study, various suggestions were presented that would lead to research on mathematics efficacy.

Key words: preschool teachers, mathematical efficacy, mathematics self-efficacy, mathematics teaching self-efficacy, teachers' views

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Introduction

Efficacy can be evaluated in the broadest sense as the capacity a person has. Demirtaş et al. (2011) defined efficacy as the level of having the necessary equipment to perform a certain task. In this context, mathematics efficacy can be expressed as the knowledge, skill, or belief (perception) required in the mathematics learning-teaching process. Mathematics efficacy, which begins to form in the preschool period when individuals actively participate in learning,

plays an important role in their mathematics life (Sarama & Clement, 2009). Fear of mathematics, loving mathematics, being excited about mathematics learning, and developing a positive attitude towards mathematics at school are associated with mathematics efficacy (Aytaç, 2020; Oktay, 2000). Individuals construct mathematics at school through the experiences their teachers convey to them. In other words, teachers make sense of mathematics through their teaching, so they can use their mathematical skills (matching, comparison, classification, ordering, pattern, estimation, etc.) in problem-solving (Tran et al., 2012). Therefore, teachers' knowledge, skills, or beliefs about mathematics not only affect their thoughts but also their interactions in the classroom, the materials they use, the activities they implement, and the teaching they perform (Sweeting, 2011).

Teachers' mathematics efficacy can be considered as a concept that can be evaluated according to both individual and teacher roles. In other words, the teacher's mathematics efficacy can be evaluated not only as having professional knowledge and skills but also as belief in the ability to put them into action. Bandura (2006) claimed that efficacy is the belief or perception that a person has according to the knowledge, skills, and roles he has, and explained this with the concept of self-efficacy. Therefore, we can define teachers' mathematics efficacy as the combination of both their personal belief in their ability to successfully plan and carry out teaching goals in mathematics (mathematics self-efficacy (Ferla et al., 2015)) and their perception of their ability to fulfill their mathematics teaching tasks (mathematics teaching self-efficacy (Zuya et al., 2016)).

Gavora (2010) stated that higher mathematics self-efficacy of teachers enables them to use their professional knowledge and skills successfully. This may mean that low mathematics self-efficacy may prevent the use of professional knowledge and skills, thus negatively affecting children's learning. This shows that the mathematics self-efficacy of teachers is important not only for them but also for the children. Achurra and Villardon (2013) pointed out that the sense of self-efficacy is associated with positive teaching behavior and stated that teachers with high self-efficacy are more likely to use effective methods in their teaching. However, Kahle (2008) stated that individual differences in teacher effectiveness are a result of mathematics teaching self-efficacy and emphasized that mathematics teaching self-efficacy should also be considered as an important variable when evaluating a teacher's mathematics efficacy.

When studies on mathematics efficacy are examined in the literature, it is recommended that mathematics self-efficacy and mathematics teaching self-efficacy be examined together to understand teachers' beliefs or perceptions about their abilities (Pajares, 1992) and to show how these affect the learning environment in the classroom (Kahle, 2008). Siegle and McCoach (2007) and Kahle (2008) stated that the teacher's mathematics efficacy affects the choice of teaching method, which in turn affects the student's mathematics self-efficacy. This means that students' learning of mathematics may be positively or negatively affected depending on whether the teacher's perception of both mathematics self-efficacy and mathematics teaching self-efficacy are high or low. However, when the studies on mathematics efficacy were examined, it was determined that some of them focused on the factors affecting teachers' mathematics efficacy. Ay (2005), in his study examining which variables affect classroom teachers' self-efficacy in teaching mathematics, stated that gender, length of service, and field of graduation do not affect the self-efficacy level. Şeker (2013) and Bülbül (2016) stated in their studies that preschool teachers' self-efficacy levels regarding mathematics education were high and emphasized that teachers' mathematics self-efficacy did not differ according to the variables of age, professional seniority, and having taken a mathematics course. It was observed that some studies focus on the relationship between teachers' mathematics self-efficacy and mathematics teaching self-efficacy. Schillinger's (2016) studies with kindergarten teachers and Ünlü and Ertekin's (2013) studies with primary school mathematics teachers revealed a positive significant relationship between mathematics teaching and self-efficacy. Finally, it could be argued that some studies focus on the relationships between mathematics efficacy and success. In a study conducted by Siegle and McCoach (2007) to increase students' mathematics self-efficacy, it was determined that there was a significant relationship between mathematics self-efficacy and mathematics success.

Almost all of the studies mentioned in the literature above are relational/descriptive studies. However, in most of these studies, teachers' mathematics efficacy was interpreted mainly with the information obtained through quantitative data collection tools (surveys, scales with Likert-type items, etc.). In this study, preschool teachers' mathematics efficacy was evaluated through interviews with the methods adopted by qualitative approaches. Thus, it was tried to collect opinions of preschool teachers regarding sub-dimensions such as mathematics self-efficacy and mathematics teaching self-efficacy, along with mathematics efficacy. In addition, preschool teachers' views on the factors affecting their mathematics efficacy and their mathematics efficacy levels were also focused on. The fact that qualitative

studies examining mathematics efficacy of preschool teachers are rare in the literature also increases the importance of this study. In summary, the aim of this study, which focused on the mathematics efficacy of preschool teachers, was to shed light on teachers' knowledge, skills, and beliefs about their potential for mathematics self-efficacy, mathematics teaching self-efficacy, factors affecting mathematics efficacy, and their efficacy levels. Thus, it was aimed to contribute to the literature by revealing what preschool teachers care about while teaching mathematics, from their perspectives. This may provide an opportunity for the field to increase the efficiency of learning/teaching mathematics directly or indirectly in preschool.

The research questions of the study were:

- What are the preschool teachers' views on mathematics efficacy (mathematics self-efficacy and mathematics teaching self-efficacy)?
- What are the preschool teachers' views on the factors affecting their mathematics efficacy?
- What are the preschool teachers' views on their mathematics efficacy levels?

Method

In this study, case study among the qualitative research approaches was preferred to reveal preschool teachers' opinions about mathematics efficacy in detail. In addition, the study was designed as a case study (Yin, 2011) to reach a deeper understanding of preschool teachers' mathematics self-efficacy, mathematics teaching self-efficacy, factors affecting efficacy, and efficacy level. The purpose of such case studies is not to produce general theories or to generalize the findings to a larger sample, but to examine a particular group in a multifaceted, systematic, and in-depth context within its real-life context (Baxter & Jack, 2008).

Participants

The study was carried out with the participation of 10 preschool teachers working at different schools in a province (Mersin) in the Mediterranean Region of Turkey in the 2022-2023 academic year. Maximum variation sampling was used in the study. This type of sampling is very common in qualitative research and involves the selection of highly diverse sites or participants. The aim is to increase the possibility of reflecting different perspectives (Creswell, 2012). In this context, attention was paid to the fact that the participants worked in different types of schools and different regions in terms of socio-economic environment. It

was also taken into account that the participants had different professional experiences. Participants were shown with letters T1, T2, T3, ..., and T10 to keep their identities confidential. Demographic characteristics of the participants is presented in Table 1.

Table 1 Demographic characteristics of the participants

Participants	Professional experience	High school graduation	Teaching group	Type of school	School location	Family interest
T1	14 years	Mathematics-Science	48-60 months	Primary school kindergarten	Village	Low
T2	11 years	Mathematics-Science	60-72 months	Independent kindergarten	Town	Low
T3	16 years	Mathematics-Science	48 months	Independent kindergarten	City	High
T4	16 years	Social studies	48-60 months	Independent kindergarten	City	High
T5	17 years	Mathematics-Science	72 months	Primary school kindergarten	Town	Medium
T6	4 years	Social studies	60 months	Secondary school kindergarten	Village	Low
T7	15 years	Vocational	60 months	Primary school kindergarten	Village	Low
T8	12 years	Mathematics-Science	48-60 months	Secondary school kindergarten	Town	Low
T9	2 years	Vocational	48 months	Primary school kindergarten	Village	Low
T10	5 years	Mathematics-Science	48 months	Independent kindergarten	Village	Low

Data collection

In this study, a semi-structured interview form consisting of 5 open-ended questions was used as a data collection tool to reveal the opinions of preschool teachers about mathematics efficacy. During the preparation process of the interview form, the questions in the interview form were examined by two experts, one in preschool education and the other in mathematics education, and it was decided that the questions were appropriate. Because two of the 7 open-ended questions created at the beginning were comprehensive, they were removed from the interview form in line with the suggestion of experts to remove them, and some questions were corrected in terms of language. Afterward, it was tested whether the questions prepared at the pre-interviews with three preschool teachers who did not participate in the current study were understood. After this process, partial corrections were made in some expressions of the interview questions. The first question in the interview form was aimed at understanding how the participants related mathematics efficacy with mathematics self-efficacy and mathematics teaching self-efficacy. The second and third questions were

aimed at understanding how the factors affecting the development of efficacy were evaluated. The last two questions were for assessing their mathematics efficacy levels. The questions in the interview form were as follows:

1. What do you think is mathematical efficacy?
- What do you think is mathematics self-efficacy?
- What do you think is mathematics teaching self-efficacy?
2. What are the factors affecting mathematical efficacy?
3. Is it possible to develop mathematics efficacy? If possible, what does this development depend on?
4. Do you think you are competent to teach mathematics?
5. What are the advantages of mathematics efficacy?

Before the actual interview, the participants were pre-interviewed and informed about the study. A suitable day and time were agreed upon with the participants for the main interview. The interviews took place face-to-face with the participants and lasted approximately 25-35 minutes. All of the interviews were recorded with a voice recorder with the permission of the participants and notes were taken during the interviews. The interviews were based on voluntary participation.

Data Analysis

The data obtained in the study were analyzed by content analysis method. In this process, the first step is coding the data, followed by creating the categories that best explain these codes by classifying the obtained codes, and organizing and interpreting the data according to the determined codes and categories (Yıldırım & Şimşek, 2005). The answers to each question posed to the participants were examined in depth. Each answer was examined repeatedly, and the inductive analysis method was adopted in the analysis process. This method provides an important advantage and convenience for organizing qualitative data (Biklen & Casella, 2007). During the coding process, the data obtained were analyzed, and divided into meaningful sections, and the meaning of each section was labeled using a word or a sentence. The categories that had common aspects based on the codes obtained were brought together. A mathematics education specialist participated in the coding of the data together with the researcher. To resolve the disagreements in the codes and reach a consensus, the differences between the codes were discussed and the codes approved by both mathematics education specialist and researcher were included in the study. On the other hand, Miles and Huberman's

(1994) formula (reliability=consensus/(consensus + opinion)) was used to ensure coding reliability. The reliability of the coding done independently by the coders was calculated as 0.92. Since it is recommended to quote directly from the data in terms of the reliability of the study in qualitative studies (Yin, 2011), some participant views were also directly reflected in the study.

Findings

According to the analysis of the data obtained, the findings were collected under three headings: the views of preschool teachers on mathematics efficacy, their views on the factors affecting mathematics efficacy, and their views on whether they found themselves competent in terms of mathematics efficacy.

Preschool teachers' views on mathematics efficacy

In this section, general thoughts of preschool teachers about mathematics efficacy were given. The codes, categories, and themes obtained as a result of the analysis were shown in Table 2.

Table 2 Codes, categories, and themes of preschool teachers' views on mathematics efficacy

Participants	Codes	Categories	Themes
T2, T3	• Desire to improve myself	Affective	Mathematics self-efficacy
T5, T4, T8	• Love, social balance, power to cope with difficulties		
T9	• It is assimilation	Cognitive	
T10	• Reasoning and using logic		
T6	• Problem-solving		
T1, T5	• To be able to give and explain mathematical concepts (numbers, patterns, shapes)	Transfer	Mathematics teaching self-efficacy
T3, T9	• To gamify, to be fun	Level	
T10	• Make it in a way that the student can understand		
T7	• to produce solutions for children	Skill	
T6	• to make children think		
T8, T2	• to concretize		

Preschool teachers' views on mathematics efficacy were grouped into two themes: mathematics self-efficacy and mathematics teaching self-efficacy. In the mathematics self-efficacy theme, two categories were determined as cognitive and affective. In the affective

category, participants defined mathematics self-efficacy as desire, social stability, and coping power. The statements of the participants are presented below.

T2; "*As a preschool teacher, I can say that mathematics efficacy is my desire to improve myself in mathematics and my desire to use different methods…I spend a lot of time on this…*" (Code: Desire to improve myself/Category: Affective)

T4; "*I think we have the power to deal with challenges and affect our way of looking at things. The education we received at the university remained purely theoretical. It was an education that made you feel like you knew nothing when you entered the classroom… I think everything starts after you enter the classroom. I have always worked in public schools with limited means... I had to deal with a lot of problems, from the math materials we wanted to use in the classroom environment to the struggle to bring the students to school. Perhaps being able to balance all of these and cope with difficulties shows my mathematics efficacy*." (Code: Love, social balance, power to cope with difficulties/Category: Affective)

It was observed that the statements in this category were made by teachers working in independent kindergartens and having a lot of professional experience. This situation strengthens the assumption that teachers' professional experiences and the types of schools they work in are related with the affective side of mathematics self-efficacy.

The other category that emerged in the mathematics self-efficacy category was cognitive. In this category, it was observed that the participants evaluated their mathematics self-efficacy as assimilation, reasoning, and problem-solving. The statements of the participants are presented below.

T9; "*Actually, I don't need a very high level of knowledge in the field of mathematics, it is my ability to make them assimilate the mathematical knowledge that we have and that we need to give to children*" (Code: It is assimilation /Category: Cognitive)

T10; *"… I think it's more a matter of logic, more of the ability to create things and solve problems…*" (Code: Reasoning and using logic /Category: Cognitive)

T6; "*Because I feel that we have to use mathematics in many problems that we think are not related to mathematics*" (Code: Problem-solving/Category: Cognitive)

Participants who evaluated mathematics self-efficacy cognitively had less professional experience compared to other participants. This showed that preschool teachers, who were in

the first years of the profession, evaluated mathematics self-efficacy according to the cognitive domain.

Another theme that emerged according to the analysis of the data obtained from the opinions of preschool teachers was mathematics teaching self-efficacy. This theme consisted of three categories: transfer, skill, and level. In the transfer category, the participants interpreted mathematics efficacy more as being able to explain concepts. The statements of the participants are presented below.

T1; "…*it is the ability to give and transfer mathematics to the child*." (Code: To be able to give and explain mathematical concepts /Category: Transfer)

T5; "*I think that mathematical efficacy shows the mathematical efficacy of the teacher, in whatever way he/she can teach mathematics to children in the flow of daily life...*" (Code: To be able to give and explain mathematical concepts /Category: Transfer)

Pre-school teachers in this theme graduated from high school mathematics-science field and used behavioral descriptions in their teaching. This situation showed that the type of high school graduates was effective in evaluating the mathematics teaching self-efficacy of preschool teachers.

In the level category, especially game teaching and student level came to the fore. The statements of the participants are presented below.

T9; "*I teach 48-month-olds and we can teach them anything through play. For example, they do not like to write numbers we teach primary school students, but they can reach a certain point in writing numbers. In the second semester, they have a little more interest, but at this age they have problems, and they may feel incompetent in this regard. I need to overcome this*" (Code: To gamify, to be fun /Category: Level)

T10; "*We teach mathematics dependent on the curriculum. This affects us and sometimes hinders us. Outdoor teaching contributes to concretization in 48-month-old children. This makes it easier for children (48 months old) to grasp. Therefore, in my opinion, mathematics can be taught more easily through gamification and concretely in open space.*" (Code: Make it in a way that the student can understand /Category: Level)

These teachers especially work with children aged 48 months. It was determined that the preschool teachers working with this group were concerned about not being able to reach the children's level while evaluating the mathematics efficacy, and therefore it could be

thought that they evaluate the efficacy according to the constructivist point of view (in terms of play and concretization).

In the skill category, the participants defined mathematics teaching self-efficacy as generalizing, prompting, and directing. The statements of the participants are presented below.

T6; "*To what extent can I direct children to mathematics in daily life…*" (Code: is to make children think /Category: Skill)

T7; "*When I encounter a problem, I see it as the ability to use numerical data and solve it. I can say that it is the ability to reason, reach a conclusion, and solve that problem by using different techniques.*" (Code: to produce solutions with children/Category: Skill)

T8; "*Actually, my ability to generalize by making mathematics concrete…I think it starts in the family…and I need their support…*" (Code: make concrete/Category: Skill)

The common aspects of preschool teachers in this category were that they were working in schools where family interest was low, and they complained about family indifference. These teachers considered teaching as a skill. And they saw mathematics teaching self-efficacy as a phenomenon that should be supported by the family.

Preschool teachers' views on the factors affecting mathematics efficacy

In this section, the views of preschool teachers on the factors affecting mathematics efficacy were given. The codes, categories, and themes obtained as a result of the analysis are shown in Table 3.

Table 3 Codes, categories, and themes of preschool teachers' thoughts on the factors affecting mathematics efficacy

Participants	Codes	Categories	Themes
T7, T6, T4	• Experiences related to mathematics	Experience	Internal
T9	• Perspective on mathematics	Attitude	
T1, T10	• Education received at university	University	External
T2	• Predominance of rote understanding	Education system	
T5, T2	• Updating the curriculum		
T1	• Large classes (Class size)	Class facilities	
T9	• Access to materials		
T7	• Family interest	Family	
T10, T9	• Readiness	Student	
T8, T7, T9	• Development Level		

When the views of preschool teachers on the factors affecting mathematics efficacy were examined, the two themes that were determined were internal and external. In the internal theme, two categories were formed: experience and attitude. In the experience category, the participants drew attention to their past experiences related to mathematics. The statements of the participants are presented below.

T7; "*For years, I have dreaded mathematics and even mathematics teachers, saying what kind of people these are, how special people are, how can they understand it. Frankly, I attribute this to not getting a good enough education. Because, as I said, there is a production that loves to learn, but unfortunately this fear could not be overcome in time, so I feel that I cannot always do it. For example, I dreamed of being able to solve very difficult questions in geometry in the past, but unfortunately, I could not achieve this goal. Maybe because I graduated from vocational high school, we rarely encountered courses related to mathematics. That is why our vocational courses were more intense, but I always envied those who could solve mathematics. I used to like it very much, but unfortunately, this remained as a shortcoming. I am currently deficient (laughs). And I cannot do anything to make up for this shortcoming…"* (Code: Experiences related to mathematics /Category: Experience)

T6; "*I add a lot of interpretation to the events and sometimes I do not perceive that I have to look at the events from one place. I do not see that problems can sometimes be solved in one way. My mother and brother sometimes looked at this from different angles. I was very impressed with them about mathematics."* (Code: Experiences related to mathematics /Category: Experience)

Another category that emerged in the internal category was attitude. Participants stated that another factor affecting their mathematics efficacy was their attitudes toward mathematics. The statements of the participants are presented below.

T9; "*Sometimes I experience learned helplessness, unfortunately, when I cannot do it . Of course, a person cannot overcome the fact of not being able to do it, unfortunately, he cannot move on to the next stage. Even though I try to understand, that negative attitude always hinders me. For example, when I took the school management exam, there were also math questions. Since I could not overcome this prejudice, I felt that I had difficulty even in simple problems…*" (Code: Perspective on mathematics /Category: Attitude)

It was observed that the statements in this category were made by teachers who graduated from the social studies and vocational fields in high school. This situation shows

that the mathematics efficacy of preschool teachers is affected by the type of high school they graduated from.

The other theme that emerged according to the analysis of the data obtained was related to external effects. This theme consisted of five categories. The education received at the university, education system, classroom opportunities, family interests, and students. Statements of the participants in the university category are as follows:

T1; "*The education received at the university is also effective. After all, at university we learn how to teach mathematics to children aged 36-72 months. The more productive this training is, the better it is for us.*" (Code: Education received at university /Category: University)

These teachers graduated from mathematics and science in high school and stated that information about teaching was important. It could be argued that they were worried about the lack of pedagogical courses.

In the education system category, the opinions of the dominance of rote understanding and the inability to follow the changes related to updating came to the fore. The statements of the participants are presented below.

T2; "*We need to use concrete materials when teaching mathematics to children. In other words, instead of drawing the dotted forms of the numbers on the paper and saying let us combine them, we need to make them more concrete and draw their attention. We need to focus on this issue a little more. This is because our education system is rote-learned, the priority is for the child to be able to write the number. He can falter when he moves to other classes.*" (Code: Predominance of rote understanding /Category: Education system)

T5; "*There are constant changes, even in the writing of numbers. It changes every year, and we do not know about it. The child moves to the next grade, but sometimes we do not know how to continue.*" (Code: Updating the curriculum /Category: Education system)

These teachers especially taught 72-month-old children. Since they were worried about primary school, they stated that the education system was a factor affecting proficiency. Therefore, they brought this to the forefront as a factor affecting teacher efficacy.

In the classroom facilities category, the participants generally stated that the class size and access to materials affect proficiency. The statements of the participants are presented below.

T1; "*sometimes class size affects our efficacy because it limits the activities you want to do…*" (Code: Large classes (Class size)/Category: Class facilities)

T9; "*The lack of materials in the classroom, or vice versa, makes it difficult/easier to teach mathematics.*" (Code: Access to materials /Category: Class facilities)

In the family category, the participants stated that family attention affects their efficacy. When the statements of the participants in this area are examined;

T7; "*I also guide families on this issue, for example, When emptying a dishwasher, I give advice such as sorting spoons and forks from larger to smaller. For counting, for example, give me five walnuts, let us eat two, let us see how many are left, or I want attention to be paid to the materials that the child touches to gain mathematical skills. I think this seems to me to be the most beautiful mathematics teaching technique. In other words, I prefer to use these methods with the help of family to gain skills.*" (Code: Family interest /Category: Family)

In the student category, the participants generally stated that their readiness and development level affect their mathematics efficacy. The statements of the participants are presented below.

T8; "*The readiness level of children is important. I think this is the most important. So are, of course, their interests and needs. For example, if I give an example from my current students, their mathematical skills are very secondary. We are now in the second semester. Generally, in the first semester, there are concepts such as feeling simple arithmetic operations, recognizing mathematical concepts and geometric shapes superficially, and showing objects as much as the number shown and the number said. I would like to do simple mathematical operations in the second semester, but I observed that they are not ready for this at the moment. For children who are in the first six months of six years of age, we show them more self-care, social skills, and more games. That is why readiness levels and children's attention needs are very effective when teaching mathematics to children. Of course, my being ready for that subject and knowing the child well are also effective. For example, sometimes the language we speak is not effective.*" (Code: Development level /Category: Student)

The common aspects of the teachers who commented in the last three categories should be working in primary school kindergarten and secondary school kindergarten within the village. These teachers saw the socio-cultural structure of the school as a factor affecting mathematics efficacy.

Preschool teachers' view on whether they find themselves competent in terms of mathematics efficacy

In this section, the opinions of preschool teachers about whether they find themselves sufficient in terms of mathematics efficacy were given. The codes, categories, and themes obtained as a result of the analysis are shown in Table 4.

Table 4 Codes, categories, and themes of preschool teachers' views on the level of mathematics efficacy

Participants	Codes	Categories	Themes
T5, T4	• I am competent because I can motivate and attract attention	Competent	Positive
T1	• not 100%	Indecisive	
T2	• I should update		
T3, T8, T10	• Even if I use different teaching methods, I don't know	Indecisive	Negative
T7	• I don't think I can	Incompetent	
T6, T9	• Being nervous while teaching		
T6	• Not being able to prepare activities		

When the opinions of preschool teachers about the levels of mathematics efficacy were examined, two themes were determined: positive and negative. Two categories emerged in the positive theme: competent and indecisive. In the competent category, participants stated that they could motivate and arouse interest in mathematics. The statements of the participants are presented below.

T5; *"... am I competent? Yes, I am competent because I think I make children interested in mathematics. I think I motivate them. I also influence their behavior. So, mathematics is a very different field. But I find this sufficient for our level.*" (Code: I am competent because I can motivate and attract attention /Category: Sufficient)

It was observed that the statements in this category were made by teachers working in schools with medium and high family interest.

In the indecisive category, teachers stated that they were not at full capacity in doing mathematics and that they needed to be updated. The statements of the participants are presented below.

T1; "*Well, I cannot say 100% like that, I mean like this: For example, I am having a hard time teaching numbers, maybe it is because families do not support me in this regard, I do not know*." (Code: not 100%/Category: Indecisive)

T2; "*because right now our information is no longer up to date. We can not stop the advancement of technology. Children are too busy with tablets and phones, which is something I am very against. We need to teach with activities that can prevent them from having tablet addiction. Children have communication problems due to tablet addiction, I need to learn more fun methods that can prevent this, teachers need to be updated on this issue.*" (Code: I should update /Category: Indecisive)

The common feature of the teachers who gave their opinions in this category was that they had a lot of professional experience. This situation showed that although teachers had a lot of experience in their profession, they felt the need to be updated in the context of mathematics proficiency over time.

Another theme that emerged according to the analysis of the data obtained was negative. This theme consisted of two categories. The statements of the participants are presented below.

T3; "*I sometimes have trouble using different techniques and methods in teaching mathematics…*" (Code: Even if I use different teaching methods, I don't know /Category: Indecisive)

Teachers who express their opinions in this category graduated from the mathematics science field in high school and were undecided in terms of mathematics efficacy. They stated that they especially had difficulties in using different teaching methods.

In the incompetent category, teachers stated that they were especially anxious about teaching some mathematical concepts and did not know what to do. The statements of the participants are presented below.

T6; "*I did not have any special studies or activity planning, especially on some mathematics subjects. It does not work, I do not have time for this, nor do I have enough materials. Nor do I think the children are ready for this*." (Code: Not being able to prepare activities /Category: Insufficient)

T7; "*I experience learned helplessness in some concepts; unfortunately, when a person cannot overcome the fact of not being able to do it, he cannot move on to the next stage. Even*

though I try, those learned helplessness always follow me, the fact that I cannot do this. For example, I feel like I have difficulty even when working on some problems in class..." (Code: I don't think I can /Category: Insufficient)

Teachers who expressed their opinions in this category were working especially in schools in villages where family interest was low.

Conclusions and Suggestions

In this study, which aimed to reveal the opinions of preschool teachers about mathematics efficacy, the participants evaluated their mathematics self-efficacy in terms of affective and cognitive dimensions. Preschool teachers with a lot of professional experience expressed mathematics self-efficacy as the desire to improve themselves in mathematics and the power to cope with difficulties in mathematics. These views showed that teachers' desire for mathematics was increasing over time, and they found the strength to cope with the difficulty to do mathematics. In addition, teachers who wanted to improve themselves in mathematics stated that they did not hesitate to try different teaching methods and they spend time on this subject. This situation could be considered as an opportunity for the development of different mathematical skills of students. The development of early mathematics skills is mostly related to the beliefs of preschool teachers towards mathematics. During this period, frequent and different activities should be done to enable children to acquire mathematical skills (Çelik, 2017). Therefore, the desire to improve oneself in mathematics could be a driving force for students' mathematical skills. On the other hand, teachers with little professional experience expressed their mathematics efficacy in terms of assimilation, reasoning, and problem-solving. The preschool period is a stage where mathematical reasoning is important (Aytaç, 2020). Contrary to experienced teachers, the fact that teachers who were in the first years of the profession cognitively evaluated mathematics self-efficacy showed that they evaluate efficacy only as teaching. Although this provides an opportunity to focus on mathematics, it may limit the usability of different methods. Therefore, it can create a disadvantage for students with different learning styles. Therefore, teachers' perspectives on mathematics self-efficacy (affective/cognitive) should be considered in studies on mathematics efficacy.

Preschool teachers who expressed their opinions about mathematics efficacy evaluated mathematics teaching self-efficacy in terms of transfer, level, and skill. Pre-school teachers who graduated from high school in the field of mathematics science stated that mathematics

was a transfer. This showed that they evaluated their mathematics teaching self-efficacy according to behavioral approaches. On the other hand, preschool teachers teaching 48-month-old children groups perceived mathematics as level. This showed that they cared about children's mathematical perceptions and gave importance to concretizing them with activities such as games. Some teachers approach mathematics efficacy as a skill. Preschool teachers with this view stated that their mathematics teaching efficacy should be supported by families. Thus, they thought that it would contribute to the generalizability of mathematics in daily life. Henson (2001) stated that teachers with high self-efficacy in teaching mathematics are always ready to accept new ideas and are willing to adopt innovations, Brouwers and Tomic (2003) believe that teachers with high self-efficacy in teaching mathematics are less likely to experience stress and believe more in students' freedom, Ross and Bruce (2007) indicated that teachers with high self-efficacy in teaching mathematics showed more interest in low-ability students. The views on mathematics teaching self-efficacy showed that mathematics efficacy was affected by different parameters. The results of this study showed that parameters such as high school graduation area, teaching group, and family may be important for studies on mathematics teaching self-efficacy. Considering the field of high school graduation as a variable related to the teacher's mathematics background, it should not be surprising that this variable affected the mathematics teaching of preschool teachers. In addition, age range was a determining factor in the mental and social development of preschool children. Therefore, it could be considered as a natural result that preschool teachers consider teaching groups when teaching mathematics. However, the role of the family as an external resource that helps the teacher in mathematics teaching should be emphasized in detail in studies to be carried out in pre-school. It is thought that the empirical level of the child's experiences in the family before encountering school mathematics may have an impact on the emergence of this result.

It was determined that internal factors such as life and attitude and external factors such as education system, university, classroom opportunities, family, and students were effective in the views of preschool teachers on the factors affecting mathematics efficacy. Preschool teachers who graduated from high school in social studies and vocational fields stated that internal factors affect mathematics proficiency. They stated that their past experiences (such as scarcity of mathematics courses, fear of mathematics, etc.) affected their perspectives on mathematics. Contrary to Ay (2005), this situation showed that internal factors such as experience and attitude were important in preschool teachers' mathematics efficacy. On the other hand, teachers who graduated from the field of mathematics science emphasized that the

pedagogical education received at the university was effective in mathematics efficacy. In particular, teachers who teach 72-month-old children stated that the education system encourages memorization and that preschool should be integrated with primary school, so the system should be updated in terms of the efficiency of their mathematical competencies. Preschool teachers, who stated that factors such as classroom opportunities, and family and student readiness affect mathematics efficacy, were found to work in schools that were more socio-culturally inadequate. Therefore, it could be argued that these variables were important in the evaluation of the factors affecting mathematics efficacy. The results of the study differed from the literature (Şeker, 2013; Bülbül, 2016) and it was determined that the mathematics efficacy of preschool teachers differed according to variables such as professional experience, the field from which they graduated from high school, the type of school they work in, family, and the group in which they are taught. This result showed that these variables should be taken into account in studies on the mathematics efficacy of preschool teachers. In particular, qualitative studies on each of these parameters could be considered important in terms of revealing how much these variables were predicted on mathematical efficacy. Therefore, qualitative research covering these parameters could be conducted moving forward.

Preschool teachers expressed their opinions on two themes regarding whether they found themselves competent in mathematics efficacy. Teachers who find themselves efficient in the positive theme were mostly teachers who worked in schools where family interest was medium and high. This showed that the family interest was effective in teachers' finding themselves competent in mathematics. In addition, these teachers stated that they were generally open to new ideas and did not hesitate to try different teaching methods. Teachers who were positive, but undecided had a lot of professional experience, but their desire to be updated over time dominated. Therefore, it could be argued that teachers with high mathematics efficacy showed more interest and commitment to teaching. Tschannen-Moran and Hoy (2001) stated that these teachers were more likely to remain in the teaching profession. The undecided teachers in the negative theme were those who graduated from high school in the field of mathematics and science, and they stated that they had difficulty using different teaching methods, therefore they did not find themselves competent. It was determined that teachers who found themselves inadequate in terms of mathematics efficacy worked in places where village and family interest was low. This showed that the socio-

cultural structure of the school was effective in the teacher's perception of her/himself as incompetent in mathematics efficacy.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

Funding

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CRediT author statement

The study was single authored and the whole process was carried out by the corresponding author.

Research involving Human Participants and/or Animals

The study involves human participants. Ethics committee permission (Date: September 26, 2023; Number: 207) was obtained from Mersin University, Social and Human Sciences Research Ethics Committee.

Okul Öncesi Öğretmenlerinin Matematik Yeterliğiyle İlgili Görüşlerinin İncelenmesi

Özet:

Bu çalışmanın amacı okul öncesi öğretmenlerin matematik yeterliliği bağlamında matematik öz-yeterliğine, matematik öğretme öz-yeterliliğine ve yeterliliği etkileyen faktörlere yönelik görüşlerini incelemektir. Çalışma 2022-2023 öğretim yılında Türkiye'nin Akdeniz Bölgesi'nde bulunan Mersin ilindeki resmi okullarda görev yapan 10 okul öncesi öğretmeni ile gerçekleştirilmiştir. Özel durum yaklaşımı ile yürütülen çalışmada katılımcılar farklı okul türlerinde ve farklı mesleki deneyime sahip öğretmenlerden oluşturulmuştur. Betimsel yöntemlerle yapılan analizler sonucu öğretmenlerin görüşleri belli temalar altında toplanmıştır. Çalışmanın sonuçları okul öncesi öğretmenlerinin matematik yeterliliğini matematik öz-yeterliliği ve matematik öğretme öz-yeterliliğini bağlamında ele aldıkları, içsel ve dışsal faktörlerin yeterlilik üzerinde etkili olduklarını ve kendilerini yeterli bulup bulmadıkları üzerinde de değişik parametrelere göre değerlendirdiklerini ifade etmişlerdir. Bu bağlamda matematik yeterliliği üzerine yapılacak araştırmalara öncülük edecek öneriler sunulmuştur.

Anahtar kelimeler: okul öncesi öğretmenleri, matematiksel yeterlilik, matematik öz-yeterliliği, matematik öğretme öz-yeterliliği, öğretmen görüşleri

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Research Article

Primary Mathematics and Turkish Teachers' Views on Distance Education: A Scale Development Study

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Abstract – This study aimed to develop a valid and reliable scale to determine the attitudes of primary school mathematics teachers and Turkish teachers who started to give distance education due to the transition from normal education to distance education during the COVID-19 pandemic. First, a literature review was conducted, and then an item pool of 119 items was created. The created items were examined by five field experts and one language expert. After the examinations, the remaining 59 items and 145 teachers in six districts of Balıkesir province were piloted, and data were collected. An explanatory factor analysis (EFA) of the collected data was performed. As a result of EFA, a scale consisting of five factors and 16 items was developed. The scale formed as a result of EFA was applied to a larger sample group (N = 321). A confirmatory factor analysis (CFA) of the obtained data was performed. As a result of the CFA, all fit indices were determined to be good or perfect. As a result, a valid and reliable scale consisting of five factors and 16 items was developed.

Key words: Distance education, attitude scale, scale development.

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Introduction

The global health crisis has resulted in several alterations and difficulties in individuals' daily routines and circumstances. One of the most prominent alterations observed was the imposition of limitations on individuals' mobility and social connections. To mitigate the spread of the virus, individuals were required to adhere to a stay-at-home mandate and practice social distancing measures, thereby minimising interpersonal interactions.

Consequently, there was a substantial rise in the utilisation of Internet, computer, phone, and tablet devices, as individuals increasingly depended on these technologies for purposes such as employment, learning, leisure, and interpersonal interaction.

The study conducted by Baltacı et al. (2020) found that undergraduate students encountered many difficulties throughout the pandemic. These obstacles encompassed the need to restrict their internet usage, adjust to distance education, and manage heightened stress and anxiety levels. During this age, the Internet has emerged as a crucial component of our daily lives, facilitating the continuation of our professional and educational endeavours from faraway locations. Many professions adopted a remote working model to reduce the risk of infection. In countries such as ours, which were significantly affected by the pandemic, face-to-face education was temporarily suspended, necessitating a transition to online platforms. Distance education has become a prevailing mode of instruction for millions of students and teachers. This educational approach encompasses a diverse range of teaching and learning methods that take place when the teacher and the learner are geographically and temporally separated. While distance education is not a recent development, its prominence has significantly increased in recent times, making it a key component of contemporary educational practices. Scholars have defined distance education differently, depending on their perspectives and contexts. For example, Özbay (2015) described distance education as a teaching method that emerged as an alternative to educational problems by planning educational activities and providing communication and interaction between practitioners and students through specially prepared teaching units and various environments at a specific centre. Kaya (2002) considered distance education as both distance teaching and distance learning, implying a dual role for the participants. Alkan et al. (2003) defined distance education as a form of teaching in which the learner and the teacher are in different places regarding time and space. Based on these definitions, we can summarise distance education as a flexible and learner-centred mode that relies on various technologies and media to facilitate learning outcomes.

The global outbreak of the COVID-19 pandemic has significantly impacted the regular operations of educational systems on a global scale, necessitating numerous institutions to transition from traditional in-person instruction to online learning methods. Nevertheless, it is crucial to clearly delineate the terms "distance education" and "emergency remote teaching." Distance education is a precisely organised and methodical endeavour encompassing various academic fields and individuals with vested interests. On the other hand, emergency distance

education can be regarded as a provisional and ad hoc measure that emerges due to the pressing necessity to sustain educational activities during a crisis (Bozkurt and Sharma, 2020). In the context of our nation, a rapid shift to emergency remote teaching has been observed throughout all educational tiers, ranging from early childhood education to tertiary education, as a consequence of the temporary cessation of formal educational activities.

Nevertheless, it is essential to acknowledge that our familiarity with distance education is not absent, as we possess a certain degree of prior experience and infrastructure in this domain. The historical origins of distance education in our nation may be traced back to the early 20th century, namely to 1923, when the concept was initially deliberated upon. However, the practical implementation of distance education did not occur until the 1970s, and it experienced significant growth in 1980 with the formation of the Anadolu University Open Education Faculty (OEF). This institution provided distance education specifically tailored for adult learners. Subsequently, as technology has progressed, there has been a notable rise in the number of educational institutions offering distance education.

Moreover, there has been a marked enhancement in the quality and variety of distance education technologies, particularly throughout the 2000s (Bozkurt, 2017). Our nation, possessing considerable expertise in distance education, demonstrated a rapid ability to adjust to the unforeseen transition to emergency distance education prompted by the COVID-19 pandemic. The Turkish Ministry of National Education employed its pre-existing technical infrastructure to facilitate online learning for students across all educational levels. The Turkish Radio and Television Corporation has introduced additional channels dedicated to the dissemination of educational content. Furthermore, it augmented the capacity and usefulness of the Education and Information Network, thereby facilitating students' access to live and recorded classes, interactive activities, and various other educational materials. In order to mitigate the digital divide, the Turkish Ministry of National Education has implemented the establishment of Education and Information Network support sites within educational institutions, community centres, and central locations in rural areas. These support points serve as physical spaces where students lacking internet connectivity can participate in real-time educational sessions. Notwithstanding these endeavours, many issues and obstacles persisted for students, teachers, guardians, and educational leaders in emergency remote teaching.

Numerous scholarly investigations have examined the issues and complexities associated with distance education across various viewpoints and contexts. Kurtüncü and Kurt

(2020) recently conducted a study that looked into nursing students' experiences with distance education. The study found that these students faced various challenges while implementing this type of learning. The challenges that were identified can be grouped into different categories. These include infrastructure problems, limitations in financial opportunities, the psychology of distance education, the lack of integration between homework and examination procedures, and the limitations of web-based applications. Kavuk and Demirtaş (2021) surveyed teachers to learn their views regarding distance education and found many different difficulties they encountered. Infrastructure issues, restrictions on student internet access, unequal access to educational opportunities, problems with the EBA system, and trouble maintaining student interest were all obstacles we had to overcome. On the other side, Devran and Elitas (2016) looked into the pros and cons of online learning. According to their findings, scholars should strongly consider the merits of distance learning. Some advantages of distance education include not having to worry about where or when you get your education, being able to learn alongside people of all ages, potentially aiding countries in overcoming educational challenges, learning quickly and easily, and tailoring your experience to fit your needs.

Nevertheless, it is imperative to acknowledge that alongside its advantages, distance learning also presents certain challenges. Concerns related to distance education often revolve around issues such as insufficient infrastructure, the quality of instruction, student readiness, faculty preparedness, and a general lack of awareness and support. Our literature analysis has allowed us to identify the following difficulties associated with distant learning.

- Teachers' technological competencies and technological problem-solving skills
- Teachers' perspectives on distance education
- The problems experienced by teachers in preparing materials and finding online materials in this process
- Student participation in live lessons in distance education
- Classroom management in distance education
- The support given by the parents to the teacher in this process
- Problems of students accessing distance education
- Infrastructure and hardware issues

Millions of students and teachers worldwide have had to turn to distant learning due to the 2019 COVID-19 pandemic, which has yet to subside. However, the uncertainty about how long the pandemic will last and when the regular education system will resume poses some

challenges and questions for the future of education. According to some written and visual media sources, the Turkish Ministry of National Education has announced that distance education will continue to be applied in some courses in our education system, even after the pandemic is over. Therefore, it is essential to understand the skills and attitudes of teachers towards distance education, which are a crucial element of education. However, a literature review revealed that few studies aimed to measure teachers' attitudes towards distance education. This study aims to fill this gap by determining the attitudes of primary education mathematics and Turkish teachers working in the Turkish Ministry of National Education towards distance education practices during the pandemic.

Methods and Procedures

Research Model

This study employed a quantitative research method to develop a scale to measure teachers' attitudes towards distance education. Quantitative research is a systematic and objective approach that uses numerical data to test hypotheses and answer research questions (Ary et al., 2002). According to Ary et al. (2002), quantitative research should consist of five main steps: literature review, instrument development, data collection, data analysis, and interpretation of results. This study followed these steps sequentially, as illustrated in Figure 1. The scale development process was based on the recommendations of Worthington and Whittaker (2006), who proposed a series of stages for creating and validating psychometric instruments. These stages include defining the construct, generating an item pool, determining the format and response options, reviewing the items, administering the items to a sample, evaluating the items, optimising the scale length, and assessing the reliability and validity of the scale.

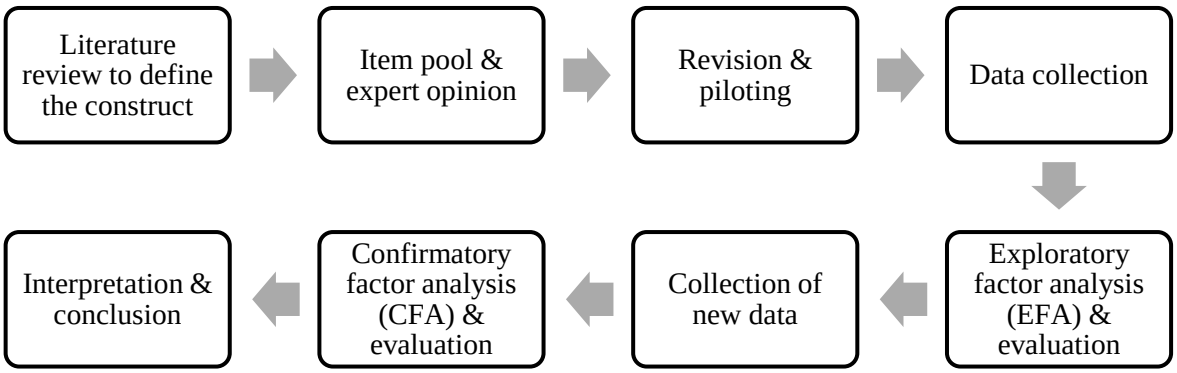

Figure 1 Stages of scale development

Scale Development

This study aimed to develop a Likert-type scale to measure the perspectives of primary mathematics and Turkish teachers on distance education during the pandemic. Since no standardised measurement tool was found in the literature review that addressed this topic, a new scale was created following the steps recommended by Worthington and Whittaker (2006) for scale development. These steps include defining the construct, generating an item pool, determining the format and response options, reviewing the items, administering the items to a sample, evaluating the items, optimising the scale length, and assessing the reliability and validity of the scale. To create the item pool, a literature review was conducted on distance education and attitude measurement (Anderson & Çıkrıkçı, 1991). A total of 119 items were generated and grouped under seven headings: “Problem Solving”, “Student Participation”, “Material Use”, “Attitude”, “Parent Contribution”, and “Classroom Management”. A literature teacher then checked these items for grammatical correctness. Next, the items were sent to three experts from different academic fields (two from Computer Education and Instructional Technologies and one from Curriculum and Instruction) for content validity. The experts evaluated the items using Google Forms and gave their opinions using the options “The sentence and category are appropriate”, “The sentence and category are not appropriate", "The sentence is not suitable for the category”, “The sentence and category are not clear”, and “Other”. At least two experts excluded items deemed inappropriate from the item pool. Before conducting the pilot study, ethical approval was obtained from the Scientific Research and Publication Ethics Committee of Balıkesir University (date: March 15, 2021; number: E.19359), and permission was obtained from Balıkesir Provincial Directorate of National Education (date: April 27, 2021; number: 24703044). The pilot study was conducted with 59 items for 145 primary mathematics and Turkish teachers working in six districts of Balikesir. The items were presented in a 5-point Likert scale format on Google Forms, with the response options ranging from “strongly disagree” to “strongly agree”.

Participants

The participants of this study were primary mathematics and Turkish teachers working in six districts of Balikesir province: Altıeylül, Karesi, Balya, Sındırgı, Dursunbey, and Susurluk. 145 teachers took part in the study. 50 teachers (34.5%) were female, and 95 teachers (65.5%) were male. The participants were split into two groups based on their areas

of expertise. 71 teachers (49%) were classified as Turkish teachers, while 74 teachers (51%) were classified as math teachers. The separation is because people who are more comfortable with words than numbers can still use the scale. Although the measurement tool was designed for mathematics teachers, The scale will be useful for teachers in any discipline in the long run.

Exploratory factor analysis relies on a sufficient sample size to guarantee the validity and reliability of the scale (EFA). Exploratory factor analysis sample size has been proposed to be determined by several criteria (EFA). Kass and Tinsley (1979) found that the sample size needed to satisfy the criteria was at least five times bigger than the number of elements on the scale. The categorisation of the sample size is another factor to consider. Depending on how many people took part, we can rate it as poor (100), average (200), good (300), very good (500), or extraordinary (1000) (Comrey & Lee, 1992). According to Field (2005), it is recommended to have a minimum sample size of 300 for exploratory factor analysis (EFA). However, a basic flat minimum of 100 participants (Kline, 1994) or a range of 50 as extremely poor, 300 as decent, up to 1000 or more as exceptional (Comrey and Lee, 1992) are acceptable minimums. The sample size of 145 in this study was deemed adequate for conducting exploratory factor analysis (EFA), since it satisfied the initial requirement and approached the secondary criterion.

Analysis of Data

The data collected from the 145 teachers who completed the final form of the scale after the expert opinion were used to conduct the validity and reliability analyses of the scale. The validity and reliability analyses are essential to ensure that the scale measures what it intends to measure and produces consistent results. The reliability analysis was performed by calculating Cronbach's alpha coefficient, which measures the internal consistency of the scale items. A high Cronbach's alpha coefficient indicates that the items are related and measure the same construct. The validity analysis was performed by conducting two-factor analyses: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Exploratory Factor Analysis (EFA) is a statistical method employed to discern the latent factors or dimensions that account for the observed variance and covariance among the items. Principal component analysis (PCA) was employed to conduct exploratory factor analysis (EFA) to extract the components that explain the highest variance in the dataset. The factor loadings, denoting the correlations between the items and the factors, were established to have a minimum value of .30, in accordance with the recommendation put forward by Büyüköztürk (2018). The

Confirmatory Factor Analysis (CFA) technique is employed to assess the degree to which the identified components and their interrelationships align with the observed data. A confirmatory factor analysis (CFA) was performed to validate the precision and sufficiency of the exploratory factor analysis (EFA) findings.

Results

In this section, we present the findings from our study, examining the validity, reliability, and confirmatory factor analysis (CFA) of the attitude scale.

Explanatory Factor Analysis (EFA)

The scale's construct validity was evaluated by doing an exploratory factor analysis (EFA) in the SPSS 24 software, employing the principal component analysis (PCA) technique. The primary objective of exploratory factor analysis (EFA) was to ascertain the fundamental factors or dimensions that account for the variability and interrelationships among the items. Before conducting exploratory factor analysis (EFA), an assessment was made to determine the appropriateness of the data matrix and the sample size for factor analysis. The calculated KMO value of 0.742 suggests that the sample size used in the factor analysis was sufficient. The statistical analysis revealed that the Barlett sphericity test yielded a significant result ($p<0.01$), suggesting that the data matrix did not exhibit an identity matrix pattern and that correlations were present among the items. In the initial EFA, 17 factors with eigenvalues greater than one were extracted (Hair et al., 1998). However, this number of factors was too large and did not match the theoretical framework of the scale. Therefore, the EFA was repeated with axis rotation, limiting the number of factors to six, the number of headings determined by the researcher during the item pool generation. Items with low or cross-loadings on multiple factors were removed individually until a clear and interpretable factor structure was obtained. However, the desired ratios could not be achieved with six factors, so the analysis was continued with five factors. After removing more items with low or cross-loadings, a final EFA was conducted with five factors with eigenvalues greater than one and explained a satisfactory amount of variance in the data. The factor loadings and eigenvalues resulting from EFA are shown in Table 1.

Table 1 Factors and item loads resulting from EFA

Item Number	F1	F2	F3	F4	F5
M10	.83				
M13	.79				
M11	.79				
M12	.75				
M15		.87			
M14		.87			
M16		.83			
M3			.89		
M2			.88		
M1			.73		
M5				.81	
M4				.78	
M6				.77	
M8					.84
M7					.80
M9					-.66

The 5-factor structure of the scale explained 70.612% of the total variance, which is a measure of how well the factors capture the variability of the items. This means that the scale has a high construct validity and that the factors represent the main dimensions of the construct. The first factor (F1) was the most dominant, as it explained 27.608% of the total variance. This factor consisted of items related to the problem-solving skills of the teachers and students in distance education. The second factor (F2) explained 14.405% of the total variance and included items related to student participation and engagement in distance education. The third factor (F3) explained 10.513% of the total variance and contained items related to material use and availability in distance education. The fourth factor (F4) explained 10.201% of the total variance and comprised items related to the attitude and motivation of the teachers and students towards distance education. The fifth factor (F5) explained 7.876% of the total variance and involved items related to the parent contribution and support in distance education. These factors were named according to their content and theoretical relevance.

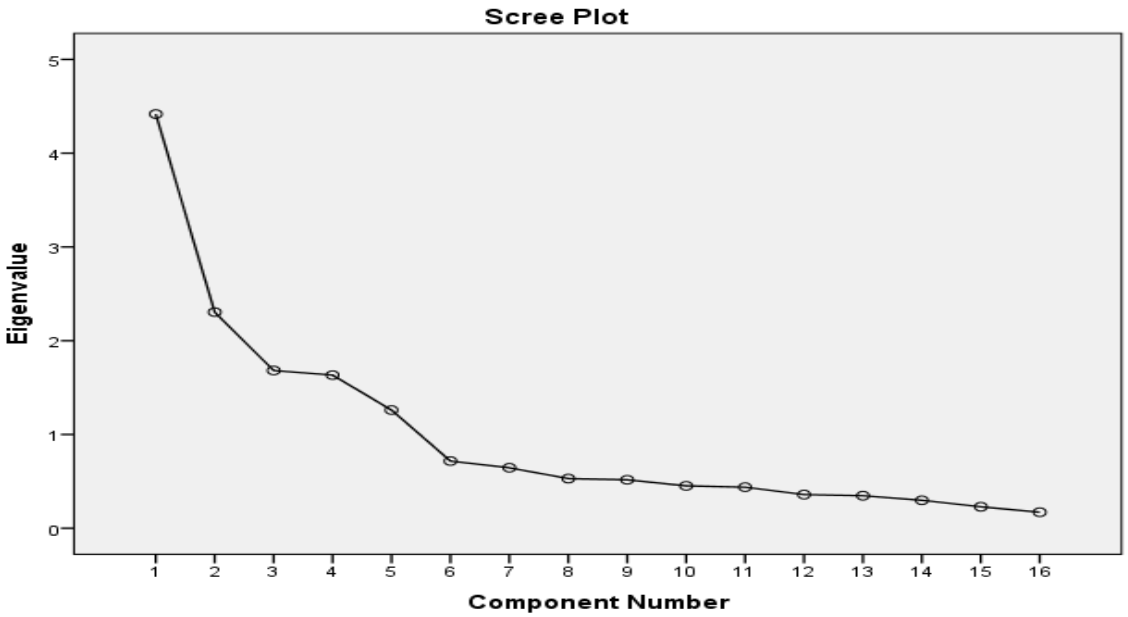

Figure 2 Scree Plot Chart

The results of the EFA showed that the scale had a five-factor structure consistent with the construct's theoretical framework. The five factors were named "problem-solving", "student participation", "material use", "attitude", and "parent contribution", based on the content and meaning of the items under each factor. There were substantial correlations between the 16 items and the four components, as indicated by factor loadings of .661 to .894. Eigenvalue, scree plot (Figure 2), explained variance ratio and factor's contribution to total variance ratio were all considered to calculate the number of factors (Field, 2005; Pallant, 2007; Tabachnick & Fidell, 2007; Okluk et al., 2010). The eigenvalue quantifies a factor's overall impact on the range of values. According to Hair et al., only factors with eigenvalues above one should be considered (1998). The scree plot is a graphical display that lists the eigenvalues of each element from lowest to highest. The primary objective here is to simplify the process of identifying the precise time at which the line's slope changes dramatically, signifying a diminishing role for the other elements (Cattell, 1966). Knowing how much variation can be attributed to various causes is the principle behind the explained variance ratio. It's useful for determining how much variation can be pinned on individual causes. To be deemed statistically significant, a component should explain at least 5% of the total variation, as Stevens (2002) indicated. The percentage of variation that each given component explains with the total variance ratio establishes the relative importance of that element. Costello and Osborne (2005) propose that a factor's contribution to the variance ratio needs to

be at least 10% for it to be considered significant. When selecting how many components to include in the scale for this investigation, we carefully considered all of these factors.

Table 2 EFA and CFA item loads for UEYTÖ

Item	(EFA)	(CFA)
M1	.73	.65
M2	.88	.67
M3	.89	.68
M4	.78	.60
M5	.81	.75
M6	.77	.69
M7	.80	.61
M8	.84	.67
M9	-.66	-.32
M10	.83	.68
M11	.79	.82
M12	.75	.86
M13	.79	.76
M14	.87	.92
M15	.87	.83
M16	.83	.76

Both the EFA and the CFA results showed that there was a lot of consistency between the item loadings (which represent the relationships between the items and the underlying variables) for the most part. The factor loadings exhibited a variety of values, specifically ranging from -.66 to .89 for exploratory factor analysis (EFA) and from -.32 to .92 for confirmatory factor analysis (CFA). The presence of a negative sign in the item loading for M9 in the context of Confirmatory Factor Analysis (CFA) signifies that the item has been subjected to reverse scoring. This implies that a higher score on the factor corresponds to a lower score. The observed pattern of item loading for M9 in the exploratory factor analysis (EFA) aligns with previous findings, indicating a negative relationship. Therefore, there was no discrepancy between the item loadings due to EFA and CFA, except for the magnitude of some values.

Confirmatory Factor Analysis (CFA)

CFA was performed to verify the situation created by EFA. The fit index values obtained for the five-dimensional scale produced by confirmatory factor analysis (CFA) were as follows: chi-square (χ^2) = 1.628, degrees of freedom (df) = 151.3, root mean square error of approximation (RMSEA) = 0.044, standardised fit index (NFI) = 0.927, comparative fit

index (CFI) = 0.970, goodness-of-fit index (GFI) = 0.945, adjusted goodness-of-fit index (AGFI) = 0.920, and root mean square residual (RMR) = 0.050. A confirmatory factor analysis (CFA) was conducted to assess the congruence of the data (N=321) with the factors derived from the exploratory factor analysis (EFA). The corresponding values can be found in Table 3.

Table 3 CFA fit model of UEYTÖ

Index	Good Fit	Statistics	Rationale
χ^2/df	$0 \leq \chi^2/df \leq 2$	1.628	Tabachnick & Fidell (2005)
χ^2	$0 \leq \chi^2 \leq 2$	151.4<360	Yilmaz & Celik (2009)
p-value	$.05 \leq \chi^2 \leq 1$	<.000	Hoyle (1995)
RMSEA	.00 ≤ RMSEA ≤ .05 .00 ≤ RMSEA ≤ .08	0.044	Schumacker & Lomax (2004), Raykov & Marcoulides (2006), Hooper et al. (2008), Steiger (2007)
CFI	.95 ≤ CFI ≤ 1.00	0.970	Hu & Bentler (1999)
GFI	.90 ≤ GFI ≤ 1.00	0.945	Hu & Bentler (1999)

The adequacy of the CFA results presented in Table 3 was assessed using multiple criteria, including the root mean square error of approximation (RMSEA), the goodness of fit index (GFI), and the p-value. To determine how well a model fits the data, the RMSEA is used. It considers both the size of the sample and the complexity of the model. RMSEA is a statistical measure of how well an approximation fits the data. Some authorities have suggested that a value of less than 05 indicates a substantial likelihood of a good fit (Schumacker & Lomax, 2004; Raykov and Marcoulides, 2006). According to the results, the model fits the data very well (RMSEA =.044). A metric called the goodness-of-fit index (GFI) is used to evaluate how well a model fits the data. The measurement is represented on a scale ranging from 0 to 1. A higher GFI value indicates a better fit, according to scholarly literature. It is suggested that a value above .90 is considered to show a good fit (Hu & Bentler, 1999; Kline, 2011). Based on the GFI value of .91 found in this investigation, it can be concluded that the model fits satisfactorily. The p-value helps us understand how statistically significant the model is by showing us if it significantly differs from the observed data. When the p-value is larger, it indicates no significant difference between the model and the data. Some studies suggest that a threshold of more than 0.05 is considered acceptable (Hooper et al., 2008; Kline, 2011). In this study, we found that the calculated p-value was .06, which suggests that it is close to the commonly accepted threshold. Figure 3 gives a clear summary of the data we gathered through the CFA analysis.

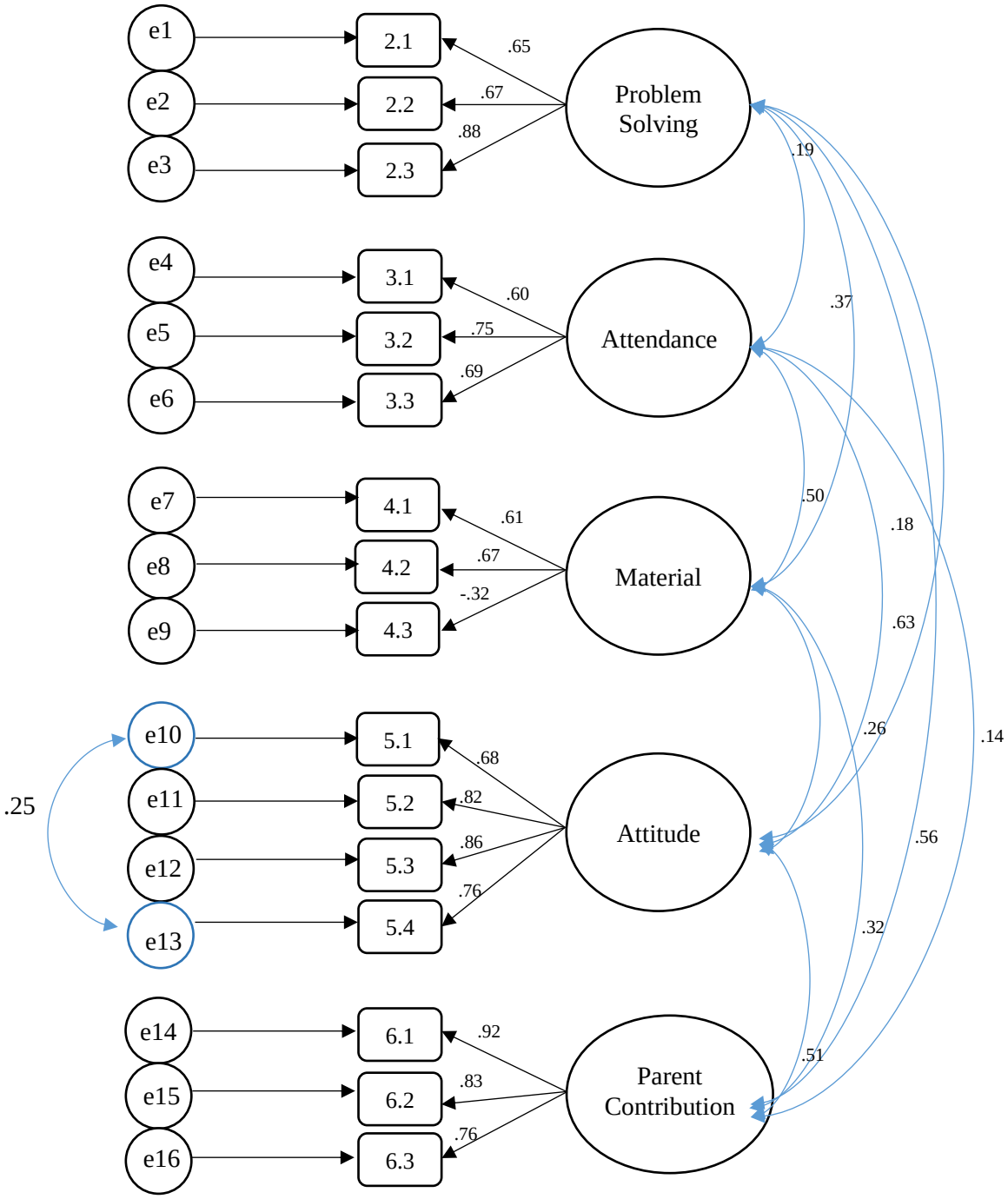

Figure 3 Values diagram of items CFA according to UEYTÖ

The results of Figure 3 show that the model-data fit is good for the scale, which is named "Primary Mathematics and Turkish Teachers' Perspectives on Distance Education during the Pandemic Process" (UEYTÖ). The scale is highly valid, as both EFA and CFA confirmed it. The scale consists of five factors and 16 items, as shown in Table 4. The items have high loadings on their respective factors, except for item 43, which has a moderate loading of .32. However, this item was not removed, as it still contributes to the measurement

of the construct. Items 5.1 and 5.4 have some similarities in their content but were not removed, as they measure different aspects of the same factor. The scale is a reliable and valid instrument that can be used to assess the perspectives of primary mathematics and Turkish teachers on distance education during the pandemic process.

Table 4 UEYTÖ factors and items

Factor Name	No.	Materials
Problem Solving	M1	I solve technical problems on my computer myself.
	M2	Understanding the English language of ZOOM is not hard for me.
	M3	I quickly solve the problems I have while using ZOOM.
Student Participation	M4	During the live lesson, students make my job easier.
	M5	During the live lesson, students are more active.
	M6	Students come prepared to the live lesson.
Material Usage	M7	Before the lesson, I send the students preparation materials.
	M8	I use eye-catching visuals in live course content.
	M9	I find it difficult to find materials in the distance education process.
Attitude	M10	I believe that distance education is the future of our education system.
	M11	I think that I process some gains in distance education more efficiently than face-to-face education.
	M12	I think that distance education has a positive effect on the success of students.
	M13	I would like distance education to continue when the pandemic process ends.
Parent Contribution	M14	Parents also support me during the distance education process.
	M15	Parents make it easier for me to control students' homework.
	M16	Parents allow students to participate in the live lesson.

Discussion

The objective of this study was to construct a scale that could effectively assess the attitudes of primary mathematics and Turkish teachers regarding distance education in the context of the pandemic. The scale was specifically developed to encompass the perspectives of two distinct academic disciplines: a quantitative field (mathematics) and a linguistic field (Turkish language). Nevertheless, the scale items possess a level of generality that allows for their use to encompass all teachers engaged in the realm of distance education. The measurement instrument utilised in this study is a Likert-type scale consisting of five response options, ranging from strongly disagree to strongly agree. There are a total of 16 items on the scale, and they cover five different dimensions of analysis. A score between 16 and 80 can be obtained on this scale. A higher score indicates that respondents see distance learning more favourably. The scale's demonstrated reliability and validity make it a valuable instrument for scientific study and evaluation.

This research validates the scale as a viable and reliable instrument for gauging primary mathematics and Turkish teachers' perspectives on distance education during the pandemic. We calculated the scale's reliability using a statistical tool called the Cronbach's alpha (CA) coefficient. Using this statistic, we may determine whether or not the scale's items are generally consistent with one another. We calculated a coefficient alpha (CA) for the scale and found that it had a very high level of internal consistency at .818. That all the elements on the scale measure the same underlying concept provides strong evidence for that conclusion. A coefficient alpha (CA) value of 70 or above is commonly used as a cutoff for determining a measurement's credibility among experts in the field (Anastasi, 1982; Büyüköztürk, 2007). We evaluated the scale's reliability in several ways, including its aesthetic appeal, content, construct, and model fit. We have assessed the materials and consulted with specialists to ensure their credibility and applicability. The researchers employed both exploratory and confirmatory factor analysis (EFA and CFA, respectively) to ensure that the study's measures and model were valid and reliable. Finding a KMO of 0.742 for the scale indicates that enough data were collected for the exploratory factor analysis (EFA). Statistical analysis using the Bartlett test revealed highly significant correlations ($p<0.01$) between the variables.

Using exploratory factor analysis (EFA), the data was broken down into five categories, each containing 16 items. A total of 70.612% of the observed variation can be attributed to these causes. According to prior research (Kline, 2005; Scherer et al., 1988), this value has enough construct validity. The CFA confirmed the five-factor structure, showing that the model fits well. This was supported by various criteria such as RMSEA, GFI, and p-value. Therefore, we can conclude that the 16-item attitude scale mentioned earlier has the required qualities of reliability and validity. This makes it suitable for evaluating teachers' attitudes towards distant education.

Due to the COVID-19 pandemic, many teachers and learners have had to adapt to using distance education. However, distance education brings forth various challenges and possibilities regarding the effectiveness and quality of teaching and learning. Therefore, it is crucial to understand the viewpoints of teachers regarding distance education, considering their essential role as key participants and facilitators in the field of education. Teachers' attitudes can greatly influence their motivation, performance, satisfaction, and ability to adapt to the challenges of distance education. Several aspects have the potential to influence teachers' attitudes within the context of distance education. These elements include technological difficulties, the availability of instructional materials, student engagement and

participation, parental involvement, and effective classroom management strategies. The aforementioned elements constitute the basic characteristics of the scale that was established in this research to assess the viewpoints of primary mathematics and Turkish teachers regarding distant education in the context of the pandemic. The scale is an instrument that demonstrates both reliability and validity, making it suitable for evaluating distance education's strengths and drawbacks from the teachers' perspective. The outcomes of the scale can offer significant insights and feedback for enhancing the quality and efficacy of distance education. The findings can also aid in identifying teachers' requirements and anticipations pertaining to training, assistance, and resources for distance education. Hence, it is advisable to employ this scale to assess all teachers' perspectives on distance education and disseminate the results to the Turkish Ministry of National Education and other pertinent stakeholders.

Conclusions and Suggestions

The study aimed to create a scale to assess the attitudes of primary mathematics and Turkish teachers regarding distance education during the pandemic. The researchers followed Worthington and Whittaker's guidelines, following a process of defining the construct, generating an item pool, determining the format and response options, reviewing the items, administering the items to a sample, evaluating their responses, optimizing the scale's length, and assessing its reliability and validity. The scale contained 16 items organized into five factors: problem-solving, student engagement, material utilization, attitude, and parent feedback. The analysis revealed that the scale was dependable and accurate in assessing the perspectives of Turkish and primary mathematics teachers on distance education during the pandemic.

The findings establish a framework for future research and applications in the real world. It is recommended that the scale be administered to a broader spectrum of teachers, including those from various subject areas, educational levels, geographical regions, and sociocultural backgrounds. This would provide a comprehensive evaluation of the scale's applicability to diverse scenarios and its feasibility for actual use.

The scale can help evaluate teachers' perspectives on distance education both before and after the pandemic, analyse possible variances in attitudes among different groups of teachers, and examine how teachers' perspectives relate to their teaching efficacy, student academic achievement, satisfaction, motivation, and adaption to the distance education context. It can also assess the requirements and expectations of teachers regarding training, support, and

resources for distance education. Additionally, the scale can provide valuable comments and suggestions for enhancing the quality and efficacy of distance education, particularly from the teachers' perspective.

This study's findings are an important addition to the current body of information on distance education since they present a reliable and valid instrument that can be used for research and evaluation. The findings also have practical consequences for policymakers, administrators, teachers, parents, and students who participated in distant education during the pandemic. Understanding teachers' attitudes towards distance education can enhance their motivation, performance, satisfaction, and adaptation to distance education. Addressing their challenges and problems and providing them with appropriate training, support, and resources for distance education is also possible. By doing so, distance education is hoped to become a more effective and efficient mode of teaching and learning during and after the pandemic.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

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CRediT author statement

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Research involving Human Participants and/or Animals

When reporting studies that involve human participants, authors should include a statement that the studies have been approved by the appropriate institutional and/or national research ethics committee and have been performed in accordance with the ethical standards.

İlköğretim Matematik ve Türkçe Öğretmenlerinin Uzaktan Eğitime Bakışları: Bir Ölçek Geliştirme Çalışması

Özet:

Bu çalışmada COVİD-19 pandemisi döneminde normal eğitime ara verilerek uzaktan eğitime geçilmesi nedeniyle, uzaktan eğitim vermeye başlayan İlköğretim Matematik ve Türkçe Öğretmenlerinin uzaktan eğitime yönelik tutumlarını belirlemek için geçerli ve güvenilir bir ölçek geliştirme amaçlanmıştır. İlk önce alanyazın taraması yapılmış, daha sonra ise 119 maddelik madde havuzu oluşturulmuştur. Oluşturulan maddeler 3 alan uzmanına ve 1 dil uzmanına incelettirilmiştir. İncelemelerden sonra kalan 59 madde ile Balıkesir ili 6 ilçesinde 145 öğretmene pilot uygulama yapılarak veriler toplanmıştır. Toplanan verilerin Açıklayıcı Faktör Analizi (AFA) yapılmıştır. AFA sonucu 5 faktör ve 16 maddeden oluşan bir ölçek geliştirilmiştir. AFA sonucu oluşan ölçek daha büyük bir örneklem grubuna uygulanmıştır(N=321). Elde edilen verilerin Doğrulayıcı Faktör Analizi (DFA) yapılmıştır. DFA sonucu tüm uyum indeksleri iyi uyum ve mükemmel uyum olarak tespit edilmiştir. Tüm bunların sonucunda geçerli ve güvenilir 5 faktör ve 16 maddeden oluşan bir ölçek geliştirilmiştir.

Anahtar kelimeler: Uzaktan eğitim, tutum ölçeği, ölçek geliştirme.

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Research Article

Students' Spatial Abilities, Attitudes towards Geometry, and Van Hiele Geometric Thinking Levels*

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Abstract – The aim of this study was to investigate the relationships between eighth grade students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels. We conducted the study using exploratory correlational research model with 429 students. The students' spatial ability and attitudes towards geometry were moderate, and their Van Hiele geometric thinking levels were extremely low. We discovered that the students' spatial ability scores and Van Hiele geometric thinking levels differed depending on their pre-school attendance status and did not differ according to their gender and that their attitudes towards geometry were independent of gender and pre-school attendance status. The students' spatial abilities and Van Hiele geometric thinking levels were positively associated with their attitudes towards geometry.

Key words: spatial ability, attitude towards geometry, Van Hiele geometric thinking levels, eighth grade students

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Introduction

One of the most essential concepts in curriculum of mathematics is geometry. It is not only in course programs but also in all areas of life. Geometry helps to understand abstract concepts in the context of problem solving and mathematical forms, and everyone needs geometry to describe the World and solve problems, regardless of their profession (Hannula

* This study is part of the master's thesis prepared by the first author under the supervision of the second author.

& Toivanen, 2019). Students have difficulties to understand and connect simple geometrical concepts (Watan & Sugiman, 2018). Reasons for this are teaching geometry with traditional methods, introducing geometric shapes and objects only superficially without making a connection between properties of shapes and objects, students not trying to understand geometry, and having a negative attitude and fear of geometry (Jones & Tzekaki, 2016; Sinclair et al., 2016).

Spatial ability, spatial visualization ability, and spatial or visuospatial reasoning are some of the most crucial factors of geometry success (Ben-Chaim et al., 1986; Bruce et al., 2017; Owens, 2015; Woolcott et al., 2020). The ability to perceive three-dimensional objects, construct them by imagining in mind, not divert attention away from the object in the face of any stimuli, manipulate, move, and rotate objects, and perceive objects from differing viewpoints is known as spatial ability. Spatial ability is defined as the ability to recognize and combine objects by breaking them down into smaller pieces (Owens, 2015). The definition of the concept of spatial ability used in this study was made as describing a construction called "buildings" made of small cubes by using types of representations that are two-dimensional flat view, three-dimensional corner view, and map plan (Ben-Chaim et al., 1986).

In literature, there were studies examining relationships between spatial ability with variables such as mathematics success, attitude towards mathematics, geometry achievement, attitude towards geometry, Van Hiele geometric thinking levels, gender, age, school type, pre-school attendance status, early toy experience, interest in music, frequency of playing computer games, mathematical thinking skill, linguistic situations, cultural settings and ecocultural experiences as well as studies examining students' spatial abilities (Battista, 1990; Fitriyani et al., 2021; Ganley & Vasilyeva, 2011; Gutiérrez et al., 1991; McCoun, 1993; Okamoto, 2014; Owens, 2014, 2015, 2020a; Resnick et al., 2020; Turğut, 2007; Turğut & Yılmaz, 2012; Xie et al., 2019). There were also experimental studies that focused on effect of instructional methods on improving students' spatial abilities (Bofferding & Kocabas, 2021; Choo et al., 2021; Conceição & Rodrigues, 2021; Hannula & Toivanen, 2019; Batdal Karaduman & Davaslıgil, 2019; Lusyana & Setyaningrum, 2018; Newman et al., 2016; Owens, 2020b; Pujawan et al., 2020; Septia et al., 2018; Topraklıkoğlu & Öztürk, 2021; Wahab et al., 2017).

Another crucial factor in geometry success is attitude (Al-ebous, 2016; Sunzuma et al., 2012). Attitude is defined as the affective characteristic of behavior of individuals towards

situations they encounter (Al-ebous, 2016; McCoun, 1993). Attitude towards geometry is defined as an orientation that includes all of one's thoughts, feelings and behaviors towards geometry, activities related to geometry, geometry teachers, and individual effects of geometry on students (Al-ebous, 2016).

In literature there were studies examining students' attitudes towards geometry, and studies examining relationships between attitude towards geometry and variables such as geometry readiness, geometry self-efficacy, geometric proof knowledge, geometry achievement, spatial ability, Van Hiele geometric thinking levels, and academic success (Abdelfatah, 2011; Bal, 2012; Cansız Aktaş & Aktaş, 2013; Sevgi & Gürtaş, 2020; Sunzuma et al., 2012; Topraklıkoğlu & Öztürk, 2019). There were also experimental studies investigating the effect of various instructional methods on students' attitudes towards geometry (Al-ebous, 2016; Duatepe, 2004).

Geometric thinking levels of students are also effective in geometry success (Duatepe, 2004). Van Hiele geometric thinking levels are the most well-known (Al-ebous, 2016; Duatepe, 2000, 2004; Gutiérrez et al., 1991; Kılıç et al., 2007; Ma et al., 2015; Misnasanti & Mahmudi, 2018; Pujawan et al., 2020; Van Putten, 2008; Watan & Sugiman, 2018; Wu & Ma, 2005, 2006). Van Hiele geometric thinking levels are associated with early life experiences as well as the quality of someone's education. Age has an insignificant effect on the development of levels (Usiskin, 1982). Throughout their educational careers, students remain at least one Van Hiele geometric thinking level. There is progression between levels, in that students are unable to advance to the next level without completing the previous one (Usiskin, 1982).

Usiskin (1982) defined Van Hiele geometric thinking levels as Level 0 (visual level), Level 1 (analysis), Level 2 (informal deduction), Level 3 (formal deduction, deduction), and Level 4 (seeing relationships, most advanced level, rigor).

Level 0 (Visual Level)

Students perceive objects and models as a whole at the visual level (Usiskin, 1982). Students are unable to recognize properties of objects; instead, they attempt to make sense of what they perceive by observing and imitating from daily life. For example, the definition of a rectangle is a quadrilateral whose opposite sides are equal and parallel to each other, and whose adjacent sides are perpendicular to each other is not particularly useful for students to

recognize objects. The more frequently students encounter an object in their daily lives, the more meaningful object becomes to them.

Level 1 (Analysis)

Students compare, categorize, and analyze properties of geometric objects at this level (Usiskin, 1982). Students at this level evaluate object as a whole rather than understanding properties of objects separately. For example, students are unable to know that a rectangle is also a parallelogram.

Level 2 (Informal Deduction)

Students are able to make informal inferences and make connections between objects at this level. For example, students might understand that opposite sides of a rectangle are parallel, and so a rectangle is a special type of parallelogram. Students are able to understand a proof, but they are unable to construct one (Usiskin, 1982). Students understand concepts, but they are unable to make inferences on their own (Usiskin, 1982).

Level 3 (Deduction)

The most significant difference of deduction level from other levels is that students are able to do proof themselves. Students are able to make induction and perceive properties of objects separately (Usiskin, 1982).

Level 4 (Rigor)

Students recognize similarities and differences in different geometric systems at this level. They are able to also transfer and apply Euclidean geometry theorems to non-Euclidean geometry (Usiskin, 1982).

Van Hiele geometric thinking levels range from Level 1 to Level 5, according to Senk (1989). She used Level 1 for visual level, Level 2 for analysis, Level 3 for informal deduction, Level 4 for formal deduction, Level 5 for rigor, and level 0 for students who were not at visual level. We used Senk's (1989) definition in this study.

In literature, there were studies examining students' Van Hiele geometric thinking levels and studies examining relationships between Van Hiele geometric thinking levels and variables such as geometry achievement, attitude towards geometry, spatial ability, learning styles, gender, visual proof skills, geometric concept, teachers' instructional practices and mathematical thinking skills (Duatepe, 2000; Gutiérrez et al., 1991; Guven & Okumus, 2011;

Ma et al., 2015; Polat et al., 2019; Özsoy et al., 2004; Tso & Liang, 2001; Turğut, 2007; Usiskin, 1982; Van Putten, 2008; Watan & Sugiman, 2018; Wu & Ma, 2005, 2006). In addition, there were studies investigating effect of teaching practices to improve students' Van Hiele geometric thinking levels (Duatepe, 2004; Duatepe-Paksu & Ubuz, 2009; Forsythe, 2015; Gal & Lew, 2008; Kılıç et al., 2007).

The relationship between geometric objects such as a construction made of small cubes and their properties should be understood. Visualization, rotation, movement, and remembering when required are relationships in consideration. The development of spatial ability is directly correlated with these (Newman et al., 2016; Topraklıkoğlu & Öztürk, 2021). Ability to construct geometric relationships increases as Van Hiele geometric thinking levels increase (Jones & Tzekaki, 2016; Sinclair et al., 2016).

Attitude towards geometry is one of the most crucial factors in developing geometric relationships and increasing geometry success (Al-ebous, 2016; Sinclair et al., 2016; Sunzuma et al., 2012). Balacheff (1990) stated that spatial ability and Van Hiele geometric thinking levels were critical issues for learning and teaching geometry and suggested that relationships between these concepts and other mathematical abilities should be investigated. Since then, studies have been conducted to reveal relationships between spatial ability and attitudes towards mathematics (Ganley & Vasilyeva, 2011; McCoun, 1993; Yıldırım Gül & Karataş, 2015); relationships between attitudes towards geometry and Van Hiele geometric thinking levels (Bal, 2012), relationships between spatial ability and Van Hiele geometric thinking levels (Gutiérrez et al., 1991; Kösa & Kalay, 2018; Misnasanti & Mahmudi, 2018; Tso & Liang, 2001). Although there were studies in literature examining relationship between spatial ability and attitude towards mathematics (Ganley & Vasilyeva, 2011; McCoun, 1993; Yıldırım Gül & Karataş, 2015), we found one study in literature that reveals relationship between spatial ability and attitude towards geometry (Topraklıkoğlu & Öztürk, 2019). Bal (2012) stated that attitude towards geometry related to geometry achievement and Van Hiele geometric thinking levels. The reason we would like to investigate attitudes towards geometry instead of attitudes towards mathematics was that we thought that attitudes towards mathematics are broader compared to attitudes towards geometry. We also thought that spatial ability, attitude towards geometry and Van Hiele geometric thinking levels had a more direct relationship. Accordingly, we hypothesized that there was a relationship between spatial ability, attitude towards geometry, and Van Hiele geometric thinking levels, therefore we designed this study to investigate relationship between these variables. Researching the

relationship between spatial ability, attitude towards geometry and Van Hiele geometric thinking levels will contribute to the field of geometry teaching. In addition, teachers' attention to this relationship while planning their lessons is able to positively affect geometry success (Jones & Tzekaki, 2016). Thus, by taking necessary precautions for the instruction of teachers and teacher candidates, teaching practices regarding relationships between these variables can be planned and implemented (Jones & Tzekaki, 2016; Newcombe, 2010). Investigating whether the relationship between spatial ability, attitude towards geometry, and Van Hiele geometric thinking levels is meaningful in terms of different variables and making suggestions on this subject through interpreting the results may also contribute to field of geometry teaching (Sinclair et al., 2017). In the study, we aimed to investigate what eighth grade students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels were and whether these variables differ according to the students' gender, mathematics success grade and pre-school attendance status. We expressed the study's sub-problems as follows:

1. What were the students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels?

2. Did gender, mathematics success grade and pre-school attendance status affect the students' spatial abilities, attitudes towards geometry scores, and Van Hiele geometric thinking levels?

3. What was the relationship between the students' spatial abilities, attitudes towards geometry scores and Van Hiele geometric thinking levels?

Method

Research Model

We used the exploratory correlational model as the research model in this study. The exploratory correlational research model is used to make explanations by examining relationships between variables (Fraenkel & Wallen, 2012). We investigated relationship between the students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels in the study.

Sample

The study's sample included 429 eighth grade students from seven secondary schools in two cities in Turkey, including 221 females and 208 males. The convenience sampling

method was used to select the participants. The convenience sampling method is formed by selecting participants easily to avoid wasting time, money, and labor (Fraenkel & Wallen, 2012). Table 1 summarizes the students' demographic characteristics in the sample.

Table 1 Students' Demographic Characteristics

		Gender		
Variables		Female	Male	Total
Mathematics success grade	0-44	22	20	42
	45-54	33	32	65
	55-69	33	41	74
	70-84	42	36	78
	85-100	91	79	170
Pre-school attendance status	Yes	132	119	251
	No	89	89	178

Data Collection Tools

We used four data collection tools to collect the study's data: personal information form, Spatial Ability Test [SAT] (Turğut, 2007), Attitude Towards Geometry Scale [ATGS] (Cansiz Aktaş & Aktaş, 2013) and Van Hiele Geometry test [VHGT] (Duatepe, 2000). The personal information form to determine the students' demographic characteristics included questions about gender, mathematics success grade and pre-school attendance status. We interrogated the mathematics success scores of students from the previous academic year to determine mathematics success grade.

SAT was Turkish version of MGMP Spatial Visualization Test, which was developed by Ben-Chaim et al. (1986). Turğut (2007) adapted SAT into Turkish. MGMP Spatial Visualization Test consisted of 32 questions with five options (Ben-Chaim et al., 1986). Turğut (2007) modified MGMP Spatial Visualization Test by adding items based on expert opinions instead of using items that were above the ability of secondary school students. Turğut (2007) named this new test as SAT and ensured its validity and reliability. SAT had 31 items with four options before the validity and reliability study, the test included 29 items after the study (Turğut, 2007). The lowest score was 0 while the highest score was 29 from SAT. Turğut (2007) found SAT's KR-20 reliability coefficient as .83. We presented six samples of SAT items in appendix A.

ATGS, which was developed by Cansız Aktaş and Aktaş (2013), had a total of 23 items, 11 of which were negative whereas 12 of which were positive. Responses to positive items were scored as follows: 1- strongly disagree, 2- disagree, 3- undecided, 4- agree, 5- completely agree. Answers given to negative items were vice versa. The lowest score was 23

while the highest score was 115 from ATGS. The scores on ATGS were found by dividing total scores by number of items. 1.00-1.80: "strongly disagree", 1.81-2.60: "disagree", 2.61-3.40: "undecided", 3.41-4.20: "agree", 4.21-5.00: "completely agree" scale was used to evaluate scores on ATGS. Because scores range from 1 to 5, we assumed that students had a strong positive attitude towards geometry as the scores approach 5, and a low positive attitude as the scores approach 1. Cansız Aktaş and Aktaş (2013) found ATGS's Cronbach's alfa reliability coefficient as .89. We gave ATGS items in appendix B.

VHGT was developed by Usiskin (1982) and adapted to Turkish by Duatepe (2000). VHGT consisted of 25 items. Items in range of 1-5 were level 1, items in range 6-10 were level 2, items in range 11-15 were level 3, items in range 16-20 were level 4, and items in range 21-25 were level 5. Students must answer at least three questions at the level correctly to reach the next level (Duatepe, 2000; Usiskin, 1982). We made scoring for a student who answered VHGT as follows: student got 0 point if s/he did not answer at least three questions correctly at any level. Student got 1 point if s/he correctly solved at least three of questions 1-5. Student got 2 points if s/he correctly solved at least three of questions 6-10. Student got 4 points if s/he correctly solved at least three of questions 11-15. Student got 8 points if s/he correctly solved at least three of questions 16-20 correctly. Student got 16 points if s/he correctly solved at least three questions correctly (Usiskin, 1982). The lowest score was 0, while the highest score was 31 from VHGT. Accordingly, if the sum of scores was 0 point, the level was 0. If the sum of scores was 1 point, the level was 1. If the sum of scores was 3 points, the level was 2. If the sum of scores was 7 points, the level was 3; if the sum of scores was 15 points, the level was 4. If the sum of scores was 31 points, the level was 5 (Usiskin, 1982). Duatepe (2000) found VHGT's KR-20 reliability coefficient as .82 for level 1; as .51 for level 2; and .70 for level 3. We presented six samples of VHGT's items from each level in appendix C.

Data Analysis, Validity and Reliability of Data

We coded the study's data and analyzed using statistical package program (SPSS 24). We calculated SAT's KR-20 reliability coefficient as .85, ATGS's Cronbach's alfa reliability coefficient as .82, VHGT's KR-20 reliability coefficients as .73, .75, and .23, respectively for level 1, level 2, and level 3. Because the number of students at level 3 (2 students) was too low, we thought that the reliability coefficient for this level was low. The reliability coefficients found were similar to reliability coefficients found in studies that the tests and

scale were developed, and reliability coefficients larger than .70 indicate that data is reliable (Kline, 2016).

We calculated scores on SAT and ATGS, and levels from VHGT and descriptive statistics. In addition, we examined whether the scores demonstrated normal distribution according to independent variables to choose whether to use parametric or non-parametric tests in data analysis (Ghasemi & Zahediasl, 2011; Tabachnick & Fidell, 2013). We examined skewness and kurtosis values to see whether data had a normal distribution. The skewness and kurtosis values should be in range of -1.5 and +1.5 so that data distribution does not deviate from normal distribution (Tabachnick & Fidell, 2013).

Table 2 presents skewness and kurtosis values of scores on SAT and ATGS, and levels from VHGT, as well as skewness and kurtosis values distribution by gender, mathematics success grade, and pre-school attendance status.

Table 2 Skewness and Kurtosis Values

Tests and Scale	Variables		Skewness	SE	Kurtosis	SE
SAT	-		0.028	.118	-0.873	.235
	Gender	Female	-0.024	.164	-0.690	.326
		Male	0.017	.169	-1.072	.336
	Mathematics success grade	0-44	0.889	.365	0.744	.717
		45-54	0.885	.297	0.485	.586
		55-69	-0.090	.279	-0.960	.552
		70-84	-0.075	.272	-0.138	.538
		85-100	-0.440	.186	-0.475	.370
	Pre-school attendance status	Yes	-0.105	.154	-0.775	.306
		No	0.194	.182	-0.900	.362
ATGS	-		-0.160	.118	0.617	.235
	Gender	Female	-0.326	.164	0.504	.326
		Male	0.139	.169	0.617	.336
	Mathematics success grade	0-44	-0.730	.365	1.223	.717
		45-54	-0.853	.297	2.674	.586
		55-69	0.440	.279	2.605	.552
		70-84	-0.716	.272	1.330	.538
		85-100	-0.106	.186	-0.245	.370
	Pre-school attendance status	Yes	-0.323	.154	0.499	.306
		No	0.080	.182	1.043	.362
VHGT	-	-	0.332	.118	-0.793	.235
	Gender	Female	0.321	.164	-0.684	.326
		Male	0.344	.169	-0.888	.336
	Mathematics success grade	0-44	0.457	.365	-0.642	.717
		45-54	0.950	.297	-0.133	.586
		55-69	0.757	.279	0.129	.552
		70-84	-0.454	.272	-1.014	.538
		85-100	-0.213	.186	-1.155	.370
	Pre-school attendance status	Yes	0.300	.154	-0.824	.306
		No	0.334	.182	-0.839	.362

Note. SE: standard error, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

The data had a normal distribution, according to values in Table 2. We used independent samples t-test to see whether scores on SAT and ATGS, levels from VHGT differed according to students' gender and pre-school attendance status; one-way analysis of variance [ANOVA] to see whether they differed according to their mathematics success grades because data had a normal distribution. T-test is used to evaluate the significance of the difference between the mean scores of two independent groups and ANOVA is used to test the significance of the difference between the mean scores of more than two independent groups. The variables compared in both tests should be continuous and normally distributed in the group to which they belong (Kline, 2016).

We determined the relationship between scores on SAT and ATGS, and levels from VHGT using Pearson's correlation coefficient. The correlation coefficient is used to determine the degree of relationship between two variables with a continuous and normal distribution (Kline, 2016).

We presented the results and interpretations for sub-problems in the following section.

Results

The study's first sub-problem was "What were the students' spatial abilities, attitudes towards geometry, and Van Hiele geometric thinking levels?". We calculated descriptive statistics for scores on SAT and ATGS, and levels from VHGT to answer this question. Table 3 presents descriptive statistics.

Table 3 Descriptive Statistics

Tests	N	NoQ	Minimum score	Maximum score	$\bar{x}$	SD
SAT	429	29	3	29	15.45	5.930
ATGS	429	23	1.35	5	3.24	0.596
VHGT	429	25	0	3	0.84	0.724

Note. N: number of students, NoQ: number of questions, $\bar{x}$: mean, SD: standard deviation, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

The mean score on SAT was 15.45 (Table 3). Considering that maximum score on SAT available was 29, the students' spatial abilities were moderate. Similarly, Table 3 demonstrated that mean score on ATGS was 3.24. We evaluated this score as 2.61-3.40: "undecided" according to the scale described in the Method section. Accordingly, we thought that the students' attitudes towards geometry were moderate. The mean score on VHGT was 0.84 as Van Hiele geometric thinking levels (Table 3). The students' geometric thinking levels were extremely low according to this result. 151 students were at level 0, 199 students

were at level 1 (visual level), 77 students were at level 2 (analysis), and two students were at level 3 (informal deduction) according to VHGT answers. Table 1 presents that, with exception of VHGT test, standard deviation values were not remarkably close to mean scores. The standard deviation of levels from VHGT was close to mean score, which we interpreted as levels from VHGT distributed far from the mean score.

When we examined the students' answers to the SAT one by one, we discovered that the majority of students correctly answered the 17th question (N=338). The 17th question asked how many unit cubes there were in the structure (see Appendix A). The majority of students answered the question correctly because it was an easy question that did not require viewing different perspectives. We discovered that the majority of students (N=352) answered incorrectly in the 28th question, this question was about the appearance of objects from different perspectives (see Appendix A). As a result, it was possible that students struggled to see objects from different perspectives in this question.

When we examined the students' answers on ATGS one by one, we observed that the majority of students marked item "geometry only helps me in exams" (3rd item) (see Appendix B) as "strongly disagree" (N=222) and "disagree" (N=86). The majority of students marked item "geometry helps my perception of objects in my environment" (15th item) (see Appendix B) as "completely agree" (N=70) and "agree" (N=117). We interpreted the students' answers as they consider geometry important and associate it with daily life.

When we examined students' answers on VHGT one by one, the first question (see Appendix C) that the majority of students (N=305) answered correctly includes simple basic geometric thinking. The majority of students (N=384) answered incorrectly in the 25th question (see Appendix C) because the 25th question required advanced geometric thinking.

The study's second sub-problem was "Did gender, mathematics success grade, and pre-school attendance status affect the students' spatial abilities, attitudes towards geometry scores, and Van Hiele geometric thinking levels?" We firstly analyzed female and male students' scores on SAT and ATGS, levels from VHGT to answer this question. Female students' mean score on SAT was 15.14; male students' mean score was 15.17. Female students' mean score on ATGS was 3.23, and male students' mean score was 3.26. Female students' mean level from VHGT was 0.84, male students' mean score was 0.84. We used t-test for independent samples to determine significance of differences in scores (Table 4). We controlled Levene's test for equality of variance for t-test result.

Table 4 T-test Results according to Gender

Tests	Gender	N	x̄	SD	df	t	p
SAT	Female	221	15.14	5.418	427	1.085	.279
	Male	208	15.77	6.428			
ATGS	Female	221	3.23	.636	427	.484	.629
	Male	208	3.26	.552			
VHGT	Female	221	.84	.708	427	.008	.994
	Male	208	.84	.744			

Note. N: number of students, x̄: mean, SD: standard deviation, df: degree of freedom, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

The mean scores on SAT and ATGS, and levels from VHGT did not differ significantly according to gender (Table 4) (Kline, 2016).

We analyzed the students' scores on SAT and ATGS, and levels from VHGT according to their mathematics success grade (Table 5).

Table 5 Student scores according to the Mathematics Success Grade

Tests	Mathematics success grade	N	x̄	SD
SAT	0-44	42	11.83	5.046
	45-54	65	11.23	4.749
	55-69	74	13.74	5.432
	70-84	78	15.17	4.897
	85-100	170	18.82	5.274
ATGS	0-44	42	3.15	0.576
	45-54	65	3.19	0.490
	55-69	74	3.13	0.495
	70-84	78	3.27	0.554
	85-100	170	3.32	0.683
VHGT	0-44	42	0.57	0.590
	45-54	65	0.49	0.640
	55-69	74	0.78	0.781
	70-84	78	0.68	0.497
	85-100	170	1.13	0.742

Note. N: number of students, x̄:mean, SD: standard deviation, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

The students' SAT, ATGS and VHGT mean scores differed according to their mathematics success grades (Table 5). We used ANOVA to determine the significance of differences in scores according to their mathematics success grade and we used Scheffe test or Dunnett C test according to the homogeneity of variances for paired comparisons. Scores on SAT met homogeneity of variations criterion, but scores on ATGS and levels from VHGT did not meet the homogeneity of variances criterion. As a result, we used Scheffe test for scores on SAT, and we used Dunnett C test for scores on ATGS and levels from VHGT in paired comparisons (Table 6).

Table 6 ANOVA Results According to Mathematics Success Grade

Tests		Sum of Squares	df	Mean Square	F	p	Significant difference	η^2
SAT	Between groups	3863.037	4	965.759	36.59	**.000**	A-E, B-E, C-E, D-E,	**.291**
	Within Groups	11189.033	424	26.389	7		A-D, B-D	
	Total	15052.070	428					
ATGS	Between groups	2.609	4	0.652	1.849	.119	-	-
	Within Groups	149.595	424	0.353				
	Total	152.205	428					
VHGT	Between groups	27.366	4	6.841	14.70	**.000**	A-E, B-E,	**.163**
	Within Groups	197.213	424	0.465	9		C-E, D-E	
	Total	224.578	428					

Note. df: degree of freedom, A: 0-44, B: 45-54, C: 55-69, D: 70-84, E: 85-100, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

There was a statistically significant difference between the students' mean score on SAT according to their mathematics success grade, $F(4\text{-}424)=36.597$, $p<.05$, $\eta^2=.291$ (Table 6). We calculated Cohen's d value using highest mean, lowest mean, and pooled standard deviation obtained from ANOVA results (d=1.28). We interpreted Cohen's d value of 1.28 as a large effect size (Cohen, 1988; Lenhard & Lenhard, 2016). The eta square (η^2) value indicated that 29% of variance in scores on SAT was due to mathematics success grade. According to this finding, we were able to state that there was a significant relationship between spatial ability scores and mathematics success grade at a large effect size. When we examined results for pairs of groups, we found that students with higher mathematical achievement had better spatial ability than students with lower mathematical achievement. There was no significant difference between the students' mean score on ATGS according to their mathematics success grade, $F(4\text{-}424)=1.849$, $p>.05$ (Table 6). There was a statistically significant difference between the students' mean level from VHGT according to their mathematics success grades, $F(4,424)=14.709$, $p<.05$, $\eta^2=.163$. We calculated Cohen's d value for levels from VHGT (d=0.884). We interpreted Cohen's d value of 0.884 as a large effect size (Cohen, 1988; Lenhard & Lenhard, 2016). The eta square (η^2) value indicated that 16.3% of variance in levels from VHGT was due to mathematics success grade. According to this finding, there was a significant relationship between Van Hiele geometric thinking levels and mathematics success grade at a large effect size. When we evaluated results for pairs of groups, we discovered that students in the highest mathematical achievement group had higher Van Hiele geometric thinking levels than students in lower mathematical achievement groups.

Finally, we analyzed the students' scores on SAT and ATGS, and levels from VHGT according to their pre-school attendance status to answer the second sub-problem. We used t-test for independent samples to determine the significance of differences in scores (Table 7). We controlled Levene's test for equality of variance for the t-test result.

Table 7 T-test Results according to Pre-school Attendance Status

Tests	Pre-school attendance status	N	x̄	SD	df	t	p	η^2
SAT	Yes	251	16.46	5.894	427	4.275	**.000**	**.042**
	No	178	14.02	5.700				
ATGS	Yes	251	3.29	0.628	427	1.760	.072	-
	No	178	3.18	0.545				
VHGT	Yes	251	0.89	0.751	427	1.757	.800	-
	No	178	0.76	0.681				

Note. N: number of students, x̄: mean, SD: standard deviation, df: degree of freedom, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

The students' mean score on SAT differed significantly according to their pre-school attendance status, $t(427)=4.275$, $p<.05$, $\eta^2=0.042$ (Table 9). We calculated Cohen's d value as .419. We interpreted Cohen's d value of 0.419 as a small effect size (Cohen, 1988; Lenhard & Lenhard, 2016). The eta square (η^2) value indicated that 4% of variance in scores on SAT was due to pre-school attendance status. As a result, we concluded that spatial ability scores and pre-school attendance status had a statistically significant relationship with a small effect. The students' mean score on ATGS did not differ significantly according to their pre-school attendance status, $t(427)=1.760$, $p>.05$. We were able to conclude from this result that there was no significant relationship between attitudes towards geometry scores and pre-school attendance status. The students' mean score on VHGT did not differ significantly according to their pre-school attendance status, $t(427)=1.757$, $p>05$. Accordingly, we found that there was no significant relationship between Van Hiele geometric thinking levels and pre-school attendance.

The third sub-problem was "What was the relationship between the students' spatial abilities, attitudes towards geometry scores and Van Hiele geometric thinking levels?" We performed simple and partial linear correlation analysis to determine relationships between scores on SAT and ATGS, and levels from VHGT for the answer to this question. Table 8 presents the results of correlation analysis.

Table 8 Correlations Between scores on SAT and ATGS, and levels from VHGT

Variables	N	r	p	η^2
SAT*ATGS	429	.146	.002	-
SAT*VHGT	429	.413	**.000**	**.171**
VHGT*ATGS	429	.140	.004	-

Note. N: number of students, r: Pearson's correlation coefficient, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

The scores on SAT and levels from VHGT were moderately and significantly related, r=.413, p<.05 (Table 8). Considering determination coefficient r^2=.171 and eta square (η^2) value η^2=.171, we were able infer that 17.1% of variability in Van Hiele geometric thinking levels was due to spatial ability scores. Or we were able to infer that 17.1% of variability in spatial ability scores was due to Van Hiele geometric thinking levels (Lenhard & Lenhard, 2016).

Since we found the highest correlation between scores on SAT and levels from VHGT, we used scores on ATGS as control variable in partial correlation analysis. Table 9 presents findings of partial correlation analysis.

Table 9 Partial Correlation between Scores on SAT and levels from VHGT

Control Variable	Variables	N	r	p	η^2
ATGS	SAT*VHGT	429	.401	**.000**	**.161**

Note. N: number of students, r: Pearson's correlation coefficient, SAT: Spatial Ability Test, ATGS: Attitude Towards Geometry Scale, VHGT: Van Hiele Geometry test

When we kept the scores on ATGS constant, scores on SAT and levels from VHGT were moderately and significantly correlated, r=.401, p<.05, η^2=.161 (Table 9). This correlation (r=.401) between scores on SAT and levels from VHGT was not markedly different from correlation (r=.413) calculated without scores on ATGS controlled. The correlation coefficient decreased slightly. We were able to explain decrease in correlation coefficient by relationship between scores on ATGS and SAT, and by relationship between scores on ATGS and levels from VHGT.

Discussion, Conclusions and Suggestions

A variety of variables such as spatial ability, attitude towards geometry, and geometric thinking levels affect students' ability to work geometrically or learn geometrical reasoning (Jones & Tzekaki, 2016). We examined and compared the students' scores on SAT and ATGS, levels from VHGT in terms of different variables, and investigated relationship between the students' spatial abilities, attitudes towards geometry and Van Hiele geometric

thinking levels in this study. We discussed the study's results in this section by comparing them to results of studies in literature and made suggestions for further research.

We found the students' spatial abilities and attitudes towards geometry to be moderate, and their geometric thinking levels were extremely low in the study. There were studies in literature that had similar and different results to those found in this study. Kılıç et al. (2007), Ma et al. (2015), Turğut (2007), Usiskin (1982), and Wu and Ma (2006) found that participants' geometric thinking levels were low. Polat et al. (2019) found that geometric thinking levels were moderate. Topraklıkoğlu and Öztürk (2019) found that students' spatial abilities were moderate and their attitudes towards geometry were positive. As a conclusion, we recommended that similar studies in different samples should be conducted in order to clarify situation.

We reported that the eighth-grade students' scores on SAT and ATGS, and levels from VHGT did not differ according to their gender. The results from SAT and VHGT were similar to studies conducted by Fitriyani et al. (2021), Ma et al. (2015), Turğut (2007) and, Turğut and Yılmaz (2012). However, studies (Battista, 1990; Ganley & Vasilyeva, 2011; Yıldırım Gül & Karataş, 2015) revealed that spatial ability scores differed according to gender. As a result, we were unable to clearly interpret that relationship between gender and spatial ability, as well as Van Hiele geometric thinking levels, and we recommended further studies to examine these relationships.

The scores on SAT and levels from VHGT differed according to mathematics success grades in the study, however scores on ATGS did not differ according to mathematics success grade. Topraklıkoğlu and Öztürk (2019), and Turğut and Yılmaz (2012) found that spatial ability scores differed according to the mathematics success grade. Topraklıkoğlu and Öztürk (2019) also found that attitude towards geometry scores differed according to the mathematics success grade which was similar to this study's findings. According to the results, scores on ATGS and levels from VHGT did not differ according to pre-school attendance status, however scores on SAT did. We concluded that spatial ability and pre-school attendance status had a small relationship. Similar to this study, Turğut (2007) found a relationship between eighth grade students' spatial abilities and their pre-school attendance status. Similarly, Turğut and Yılmaz (2012) found a relationship between seventh and eighth grade students' spatial abilities and their pre-school attendance status, and those who attended to pre-school were more successful than those who did not attend. As a result, we thought that

pre-school attendance status might have an effect on students' spatial abilities. But further research is needed to reach a definitive conclusion. In other words, we suggested that a type of research such as a survey, a longitudinal study or experimental research to demonstrate a straight link between pre-school attendance status and development of students' spatial abilities.

There was no study found in literature that examined the relationship between spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels. We discovered that the strongest relationship was between spatial ability and Van Hiele geometric thinking levels. According to this result, we concluded that students with increased spatial abilities had high Van Hiele geometric thinking levels. Tso and Liang (2001) and Kösa and Kalay (2018) also reported a positive significant relationship between spatial ability and Van Hiele geometric thinking levels, which was similar to this study. Gutierrez et al. (1991) found that teaching using questions in three-dimensional spatial geometry test caused an increase in ninth grade students' Van Hiele geometric thinking levels. Unlike this study, study conducted by Misnasanti and Mahmudi (2018) revealed that there was no significant relationship between spatial ability and Van Hiele geometric thinking levels. As a result, further studies are needed to understand the relationship between students' spatial abilities and their Van Hiele geometric thinking levels. We found a weak and significant relationship between attitudes towards geometry and Van Hiele geometric thinking levels in the study. Bal (2012) revealed a weak relationship between attitudes towards geometry and Van Hiele geometric thinking levels, which was similar to the study.

We also found a weak relationship between spatial ability and attitude towards geometry in the study. Topraklıkoğlu and Öztürk (2019) found a weak relationship between seventh-grade students' spatial ability and attitude toward geometry. Similarly, Ganley and Vasilyeva (2011), and Yıldırım Gül and Karataş (2015) found a statistically insignificant relationship between spatial ability and attitude towards mathematics.

Investigating the relationship between eighth grade students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels might contribute to the field of geometry teaching, considering problems and developments in the field of geometry teaching. Investigating the relationship between students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels will be beneficial as teachers will pay more attention to this relationship while planning their lessons, and students' spatial abilities, attitudes towards geometry and Van Hiele geometric thinking levels will increase.

Eighth grade students participated in the study. Similar studies might be conducted at different grade levels. We used spatial ability test, attitude towards geometry scale and Van Hiele geometric thinking test to collect data for the study. Researchers might use different data collection tools in different studies. Effects of teaching practices aimed at improving students' spatial abilities, attitudes towards geometry, and Van Hiele geometric thinking levels might be investigated by conducting research on relationships between these three variables.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

This study is part of the master's thesis prepared by the first author under the supervision of the second author.

The authors declare that they have no conflict of interest.

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CRediT author statement

Zeynep Büşra Uzun: Conceptualization, Validation, Investigation, Resources, Data Curation, Writing - Original Draft, Visualization

Gülcan Öztürk: Conceptualization, Methodology, Validation, Formal analysis, Writing - Review & Editing, Supervision

Research involving Human Participants and/or Animals

Informed consent to participate in the study was obtained from participants and their parent or guardian. Also, legal permission was obtained from the Ministry of National Education in Turkey to conduct the study. Anonymity of the participants was provided in the reporting. The authors signed the declaration stating that there was no need for ethics committee approval and submitted it to the journal because the manuscript is a study produced from a master's thesis using research data before 2020.

Öğrencilerin Uzamsal Yetenekleri, Geometriye Yönelik Tutumları ve Van Hiele Geometrik Düşünme Düzeyleri

Özet:

Bu çalışmanın amacı sekizinci sınıf öğrencilerinin uzamsal yetenekleri, geometriye yönelik tutumları ve Van Hiele geometrik düşünme düzeyleri arasındaki ilişkileri incelemektir. Araştırma keşfedici korelasyonel araştırma modeli ile 429 öğrencinin katılımıyla yürütüldü. Çalışmada öğrencilerin uzamsal yetenekleri ve geometriye yönelik tutumlarının orta düzeyde ve Van Hiele geometrik düşünme düzeylerinin çok düşük olduğu bulunmuştur. Çalışmada ayrıca öğrencilerin uzamsal yetenek puanlarının ve Van Hiele geometrik düşünme düzeylerinin okul öncesi devam durumlarına göre farklılaştığı, cinsiyetlerine göre farklılaşmadığı, geometriye yönelik tutumlarının ise cinsiyet ve okul öncesi devam durumlarından bağımsız olduğu ortaya çıkmıştır. Öğrencilerin uzamsal yetenekleri ve Van Hiele geometrik düşünme düzeyleri, geometriye yönelik tutumlarının pozitif olarak anlamlı bir şekilde ilişkili olduğu da elde edilen sonuçlar arasındadır.

Anahtar kelimeler: uzamsal yetenek, geometriye yönelik tutum, Van Hiele geometrik düşünme düzeyleri, sekizinci sınıf öğrencileri

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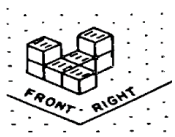
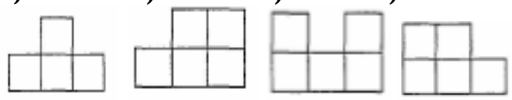
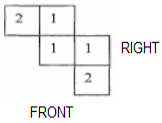
Appendix A. Four samples of SAT items (Turğut, 2007)

2. 

You are given a picture of a building drawn from the FRONT-RIGHT corner. Find the FRONT VIEW.

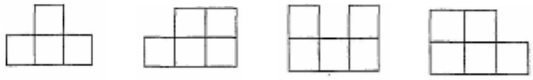
A) **B)** **C)** **D)**

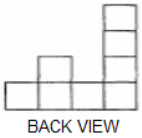


3. 

You are given the map plan of a building. Find the RIGHT VIEW.

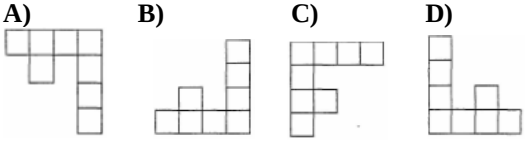
A) **B)** **C)** **D)**

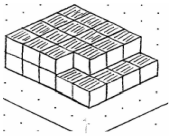


7. 

You are given the BACK VIEW o f a building. Find the FRONT VIEW.

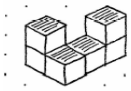
A) **B)** **C)** **D)**



17. 

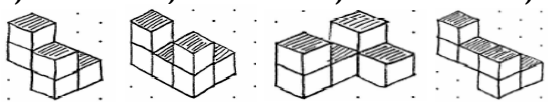
You are given a picture of a building. How many cubes were used in the construction of the building?

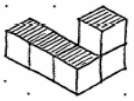
A) 17 **B)** 26 **C)** 35 **D)** 44

26. 

You are given a picture of a building. Find another view of the building.

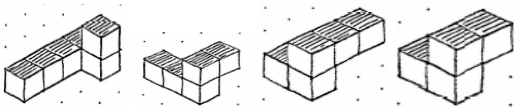
A) **B)** **C)** **D)**



28. 

You are given a picture of a building. Find another view of the building.

A) **B)** **C)** **D)**



Appendix B. English translations of ATGS items (Cansız Aktaş & Aktaş, 2013)

1. I like that a geometric problem can be solved a variety of ways.
2. Geometry is necessary for everyone.
3. Geometry only helps me in exams. (*)
4. I am unable to perform geometric proofs. (*)
5. Geometry helps in our understanding of the World.
6. I find it unnecessary to teach geometry to all students. (*)
7. I can make a geometric drawing of a figure that I see.
8. Geometric knowledge unrelated to real-life information. (*)
9. I can apply my geometric knowledge in daily life.
10. I consider myself successful in geometry.
11. I enjoy solving geometric problems in my spare time.
12. I am not confident in recognizing geometric relationships. (*)
13. I can solve a problem a variety of ways.
14. I am unable to create a geometry formula. (*)
15. Geometry helps my perception of objects in my environment.
16. I am unable to make a relationship between the subjects I learned in geometry. (*)
17. I think that geometry course should be taught only as an elective course. (*)
18. I do not feel comfortable in geometry courses. (*)
19. I can pose a solvable geometric problem.
20. I do not like to participate in conversations about geometry. (*)
21. I would like to increase the weekly course hours for the geometry class.
22. Even though it is a difficult geometric problem, I am confident that I will eventually find a solution.
23. I am unable to apply my geometry knowledge in other courses. (*)

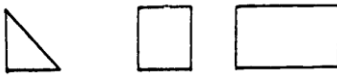
Note. *Item including negative expression

Appendix C. Five samples of VHGT items from each level (Usiskin, 1982)

Level 1

1. Which of these are squares?

(A) K only
(B) L only
(C) M only
(D) L and M only
(E) All are squares.

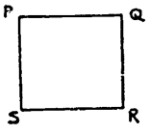


Level 2

6. PQRS is a square.

Which relationship is true in all squares?

(A) $\overline{PR}$ and $\overline{RS}$ have the same length.
(B) $\overline{QS}$ and $\overline{PR}$ are perpendicular.
(C) $\overline{PS}$ and $\overline{QR}$ are perpendicular.
(D) $\overline{PS}$ and $\overline{QS}$ have the same length.
(E) Angle Q is larger than angle R.



Level 3

11. Here are two statements.

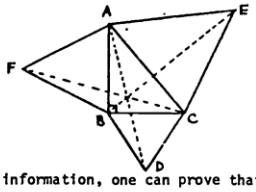
Statement 1: Figure F is a rectangle
Statement 2: Figure F is a triangle.

Which is correct?

(A) If 1 is true, then 2 is true.
(B) If 1 is false, then 2 is true.
(C) 1 and 2 cannot both be true.
(D) 1 and 2 cannot both be false.
(E) None of (A)-(D) is correct.

Level 4

16. Here is a right triangle ABC. Equilateral triangles ACE, ABF, and BCD have been constructed on the sides of ABC.



From this information, one can prove that $\overline{AD}$, $\overline{BE}$, and $\overline{CF}$ have a point in common. What would this proof tell you?

(A) Only in this triangle drawn can we be sure that $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ have a point in common.
(B) In some but not all right triangles, $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ have a point in common.
(C) In any right triangle, $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ have a point in common.
(D) In any triangle, $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ have a point in common.
(E) In any equilateral triangle, $\overline{AD}$, $\overline{BE}$ and $\overline{CF}$ have a point in common.

Level 5

21. In F-geometry, one that is different from the one you are used to, there are exactly four points and six lines. Every line contains exactly two points. If the points are P, Q, R, and S, the lines are

{P,Q} , {P,R} , {P,S} , {Q,R} , {Q,S} , and {R,S}

Here are how the words "intersect" and "parallel" are used in F-geometry.
The lines {P,Q} and {P,R} intersect at P because {P,Q} and {P,R} have P in common.

The lines {P,Q} and {R,S} are parallel because they have no points in common.

From this information, which is correct?

(A) {P,R} and {Q,S} intersect.
(B) {P,R} and {Q,S} are parallel.
(C) {Q,R} and {R,S} are parallel.
(D) {P,S} and {Q,R} intersect.
(E) None of (A)-(D) is correct.

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Research Article

Adaptive and Affective Support of Mathematics Teachers from the Perspective of Secondary School Students*

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Abstract – This study aimed to investigate the effect of affective support perceived by students on adaptive support in mathematics lessons and to examine both forms of support in terms of some variables. The correlational research method was used in this study. The study was conducted with secondary school students. Two scales measuring the perception of adaptive support and affective support were used. The relationship between students' perceptions of support was explained with a structural equation model. According to the results, affective support is significantly related to adaptive support. Therefore, in affective supportive environments, students think that they receive cognitive support that is compatible with their learning. In addition, it was determined that students' perceptions of adaptive support were independent of gender. In terms of grade level, it was observed that students in higher grades perceived that the teacher provided less adaptive support to students. There was a significant difference in perceived affective support based on both the gender and grade level of the students.

Key words: Adaptive support, affective support, student perception.

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Introduction

One of the most significant challenges worldwide is to enhance mathematics learning (Roschelle et al., 2010). Traditional mathematics instruction, where teachers demonstrate skills and students imitate and practice until proficiency, has been questioned by studies in mathematics education (Baxter & Williams, 2010). Most students have struggled with

* A part of this research was presented at the International Education Congress (Educongress2023).

mathematics and performed poorly in this instruction (Masinading & Gaylo, 2022). Different methods can be used to improve academic performance in mathematics. One of these is the teacher support strategy (Anghileri, 2006). Studies have shown that the support provided by teachers significantly impacts the academic performance of students in mathematics (Dagoc & Tan, 2018; Masinading & Gaylo, 2022; Stender et al., 2017). Therefore, it is crucial to determine the factors that account for and distinguish teacher support. This study focuses on identifying the factors that contribute to teacher support in mathematical classrooms.

As opposed to traditional teaching, teachers' changing support strategies and roles in the mathematics classroom have long been discussed (Burkhardt, 2006). Among these roles, teachers' roles of guiding, supporting or sharing authority rather than instructing students have been taken as a basis (Forman et al., 2017; Sun et al., 2022; Tabak & Baumgartner, 2004). In this context, it has become one of the frequently used concepts in education that teachers provide adaptive support suitable for students' comprehension levels (Pol et al., 2010). In particular, to support students' mathematical skills, teaching should be adapted to the needs of the students (Gallagher et al., 2022; Stender et al., 2017). Recent studies link adaptive support in mathematics education to the scaffolding theoretical framework (Bakker et al., 2015; Schukajlow et al., 2012; Smit et al., 2016).

Theoretical framework: What is scaffolding?

The concept of scaffolding is one of the concepts that emerged as a result of the adaptation of the concept of the zone of proximal development to teaching (Puntambekar, 2022). Belland (2011) defined scaffolding as bridging the gap between what students can do independently and what they can do with the help of another, more skilled person. Smit et al. (2013) define scaffolding as a teacher's temporary support that helps students complete a task that they cannot do on their own and aims to gradually provide students with the competence to complete a similar task independently. The concept of scaffolding is a metaphor for temporary support (Bakker et al., 2015). When the student reaches the potential development level, the scaffolding disappears. In order to explain scaffolding, it is first necessary to define the tool used by the teacher to scaffold. When the studies were examined, it was determined that there are different scaffolding tools in mathematics teaching. Worksheets, digital learning tools, solution plans, or material can be used as a scaffolding tool (Dove & Hollenbrands, 2014; Schukajlow et al., 2015; Tropper et al., 2015). However, in classrooms, the dialogue between the teacher and the student is often used as a scaffolding tool (Bakker et al., 2015; Stender, 2018; Stender & Kaiser, 2015; Stender et al., 2017; Tropper et al., 2015; Wischgoll

et al., 2015). The use of more dialogue can be explained by the concepts of adaptive and fixed scaffolding as defined by Azevedo, Cromley & Seibert (2004). Fixed scaffolding is static and does not change according to individual student needs. On the other hand, adaptive scaffolding is dynamic and adapts instantaneously according to student learning. Therefore, scaffolding with dialogue seems to be a very effective and appropriate tool for adaptive support (Bakker et al., 2015).

Adaptive and Affective Support

Adaptive support is defined as when a teacher adapts his/her support to the level of students' understanding (Pol et al., 2014). Adaptability of teacher support means adapting a teacher's organisation of the learning environment to the learner (Pol et al., 2022). Wood et al. (1978) also explained this concept with a degree of support. That is, when the teacher increases the degree of support in response to student failure or decreases the degree of support in response to student success, support is provided conditionally (Pol et al., 2015). Otherwise, the problem arises that the teacher does not adapt the support according to the student's needs (Pol et al., 2022). Adaptive scaffolding was found to give more favourable results than fixed scaffolding (Avezado & Hadwin, 2005). It is generally accepted in the literature that effective learning is enhanced when the teacher's support is adapted to the student's current level of understanding (Hardy et al., 2019; Pol et al., 2010; Wood et al., 1978).

Studies on dialogue support as an adaptive support tool have found that some teachers tend to provide more support than students need (Tropper et al., 2015). On the other hand, Broza and Kolikant (2015) point out that the learning processes of disadvantaged students who need more support regress with the teacher support provided. Therefore, it is important to provide adapted support to increase students' self-esteem on the one hand and to help them progress to higher levels on the other. However, providing adapted support requires the teacher to make instantaneous decisions about the support to be provided to the student and is a highly sensitive process (Bakker et al., 2015). It is a challenge for teachers to know how to support students without reducing the cognitive demand when initiating a task (González & Eli, 2015). Providing higher levels of support by the teacher to students who can only progress with lower levels of support and providing lower levels of support to students who need higher levels of support can lead to unsuccessful outcomes.

Adaptive support is a complex construct that considers two situational factors, namely teacher regulation and student understanding (Pol et al., 2022). There are studies in which adaptive support is analysed, especially regarding teachers. It has been found that variables such as the teacher's years of experience, the training received about support, and the structure of participation in the environment affect the way they support students (Gürel, 2023; Stender et al., 2017; Tropper et al., 2015). The perception of adaptive support for students was examined by Pol et al. (2022), and they found that adaptive support was related to diagnostic competence and interpersonal warmth. It was also found that teacher support was positively related to mathematics achievement (Klem & Connell, 2004; Masinading & Gaylo, 2022) and participation in mathematics lessons (Liu et al., 2018). Affective support, as well as adaptive cognitive support, which is among the types of teacher support, is an effective tool in teaching (Patrick et al., 2007; Yang et al., 2021). In the studies, it has been determined that affective support has a positive and significant relationship with academic enjoyment and academic self-efficacy (Sakız, 2017; Sakız et al., 2012). It is also mentioned that the teacher's affective support positively affects the students' cognitive and affective participation in the lessons (Klem & Connell, 2004; Liu et al., 2018). In addition, studies in the literature show that affective support is negatively related to academic anxiety (Beghetto, 2009) and hopelessness (Sakız, 2017).

Since there are gender and grade level differences in students' attitudes towards mathematics achievement, it may be important to examine these variables in adaptive and affective support (Rice et al., 2012). Pol et al. (2022) and Wang et al. (2020)'s studies show that adaptive support provided by mathematics teachers is independent of the gender and education level of the student. When the results of affective support concerning gender and grade level were analysed, it was found that in some regions, girls tended to perceive learning environments more positively than boys (Brok et al., 2006; Fusco, 2008), while in some regions, boys had more affective support perceptions than girls (Kim et al., 2000). Sakız (2017) associates this situation with cultural differences. According to grade level, it was determined that primary school students had a higher perception of social support than secondary and high school students (Demaray & Malecki, 2002; Rice et al., 2012). This study aims to examine the effect of affective support on adaptive support provided by mathematics teachers and to investigate these forms of support in terms of gender and grade variables. Within the scope of the study, the following sub-problems were included:

1. Do secondary school students' perceptions of affective support affect their perceptions of adaptive support provided by mathematics teachers?
2. Do secondary school students' perceptions of adaptive support provided by mathematics teachers differ depending on gender and grade level?
3. Do secondary school students' perceptions of affective support provided by mathematics teachers differ depending on gender and grade level?

Method

In this study, the correlational study method was used among quantitative study methods. A correlational study examines the relationship between two or more variables and how they vary together (Leedy & Ormrod, 2021). Firstly, a study was conducted to adapt a scale. Then, the direction in which the affective support variable affects the adaptive support variable was explained with the structural equation model. It was also explained how these variables were affected by gender and grade level.

Research Group

The research group consists of secondary school students studying in the first semester of the 2022-2023 academic year in central secondary schools affiliated with the Ministry of National Education in a medium-sized province of the Eastern Anatolia Region in terms of population. The study was conducted with fifth, sixth, seventh, and eighth grade students from schools selected randomly among central secondary schools. A total of 425 students and 14 teachers from five schools were included in the study. 217 students were female, 203 were male, and five students did not express an opinion. 91 of these students were fifth grade, 132 were sixth grade, 121 were seventh grade, 77 were eighth grade students. Four students did not express an opinion.

Data Collection Tools

Two data collection tools were used in this study. The first is the teacher's adaptive support scale developed by Pol et al. (2022). The second is the teacher's affective support scale developed by Sakız (2017). Information about the validity and reliability studies of the scales is given below.

Teacher's Adaptive Support: Student Perceptions Scale

Pol et al. (2022) investigated how secondary school students perceive their teachers' adaptive support. The scale consists of 21 items in total and is prepared in a five-point Likert type. The scale, which was applied to a total of 2730 secondary school students, was found to produce highly valid and reliable results. When the structure of the scale was analysed, one, two, four and six-factor structures were tested, and it was concluded that the four-factor structure of the scale was appropriate for the data. In the first level of confirmatory factor analysis, it was determined that the measurement model showed good fit values. The scale consists of 21 items in total. Information about the structure of the scale is given in Table 1.

Table 1 The Questionnaire on Teacher Support Adaptivity (QTSA): Student Perceptions

Factors	Definition	Cronbach Alpha	Items	Example Item
A+	adaptive support with much regulation upon low understanding	.88	2, 3, 7, 9, 18, 21	When I don't know how to continue, this teacher helps me to find the correct answer.
A−	to adaptive support with little regulation upon high understanding	.83	1, 4, 11, 15, 16	When I am doing well, this teacher lets me do a difficult exercise.
NA+	non-adaptive support with much regulation upon high understanding	.80	6, 13, 17, 19	When I am already able do it, this teacher still helps me.
NA−	non-adaptive support with little regulation upon low understanding	.87	5, 8, 10, 12, 14, 20	This teacher tells me to do it on my own, even though I am unable to continue.

According to the reliability analysis results conducted by Pol et al. (2022), Cronbach Alpha's internal consistency coefficient varies between .80 and .88 on a factor basis. Total reliability was determined as .85. This shows that the scale is reliable. When the scale is used depending on the student variable, it is recommended to evaluate the four factors separately. When it is used for the teacher variable, it is stated that the NA+ and NA- factors are reversed and evaluated over the scale's total score (Pol et al., 2022).

Construct Validity Study of The Adaptive Support Scale. Firstly, exploratory factor analysis was performed in the statistical package for the social sciences (SPSS) package programme and the factor structure of the scale translated into Turkish was examined. When the number of factors was released using the principal components method, it was seen that the scale had a six-factor structure with eigenvalues above one. This structure was also found in the original scale. However, the researchers decided that a four-factor structure based on the theoretical framework was appropriate. For this reason, the scale was fixed to four factors

to be suitable for the structure in the original scale and factor analysis was performed again. In the analysis, the Kaiser Meyer Olkin (KMO) test value was found to be 0.821, and Barlett's test of sphericity was significant (p<.001). Based on the analysis, it was concluded that the data collected was suitable for factor analysis. When the item-total correlations were analysed, it was found that they ranged between .289 and .609. However, there was one item below .30. It was concluded that it was acceptable to not differ from the original scale. The explained variance of this scale, which has a four-factor structure, was found to be 47%. The rotated principal components analysis is given in Table 2.

Table 2 Rotated Principal Component Analysis Results: Factor Loadings

	Factors			
Item no	A+	NA-	A-	NA+
I3	.766			
I2	.755			
I9	.723			
I7	.660			
I18	.626			
I21	.567			
I8		.690		
I5		.652		
I10		.533		
I12		.498		
I1		.428	.352	
I14		.412		
I20		.406	.356	
I15			.707	
I16			.666	
I4			.547	
I11			.498	
I13				.707
I19				.631
I6				.629
I17				.518
Total Explained variance: %47.02 Factor-1: %16.39 Factor-2: %10.87; Factor-3: %9.88; Factor-4; %9.88				

When the factor loadings were analysed, it was found that all items were loaded on the factors in the original scale. The first and twentieth items loaded on both A- and NA- factors. It was deemed appropriate to decide whether the items should remain in the scale as a result of confirmatory factor analysis. If the fit values of the structure tested in confirmatory factor analysis are sufficient and the standardised loadings produce significant results, the structure is already confirmed. Therefore, it was decided that first-level confirmatory factor analysis

should be conducted. In the analyses, the four-factor structure in the original scale was examined. The measurement model is given in Figure 1.

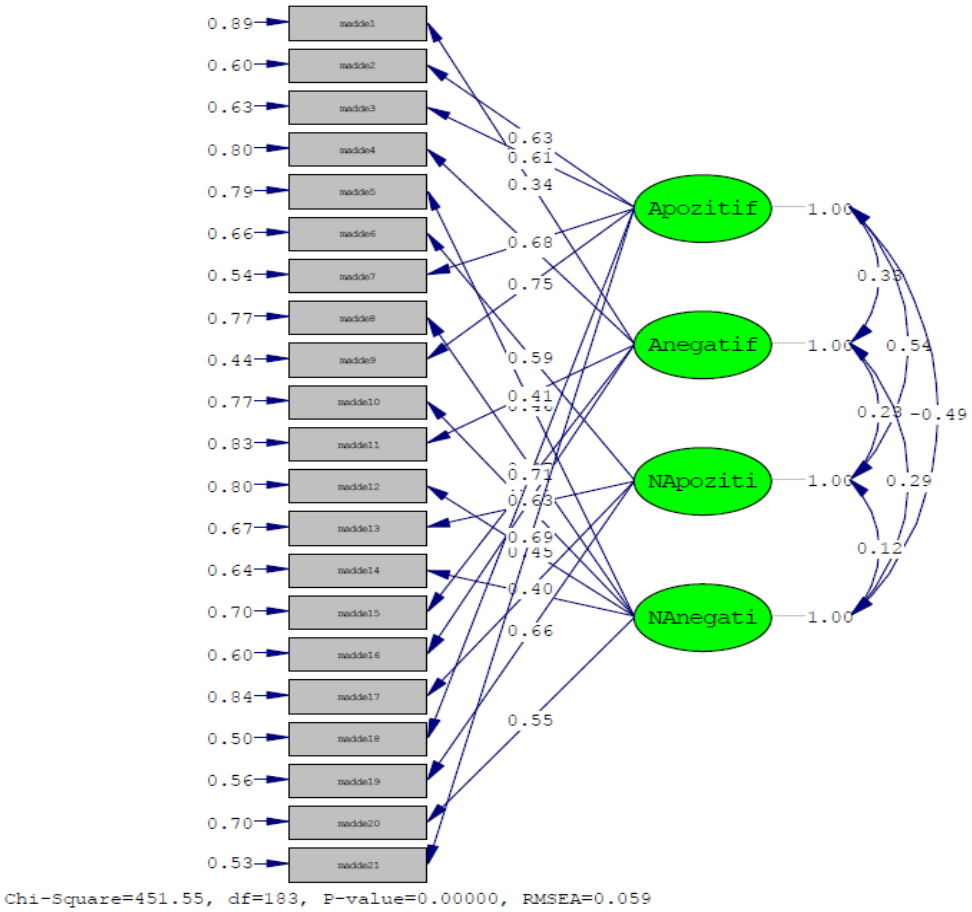

Figure 1 Path Diagram for The Measurement Model

The measurement model in Figure 1 includes standardised loadings. In addition, the error variances of the observed variables are included in the path diagram. Firstly, by looking at the fit indices, it is decided whether the measurement model is validated or not. The χ^2=451.55 and sd=183, and the data show a perfect fit with χ^2⁄sd=2.48 (Çokluk et al., 2010). The p-value of the chi-square was found to be significant. It is an expected result that this value is significant (p<.001) when the sample size is high (Çokluk et al., 2010). It was observed that RMSEA produced a good fit with a value of 0.059; GFI produced a good fit with a value of 0.91; SRMR produced a good fit with a value of 0.065, which is less than 0.08; CFI produced good fit values with a value of 0.93 and NNFI produced good fit values with a value of 0.92, which is greater than 0.90 (Çokluk et al., 2010). It was found that the

standardised loadings in the measurement model were high, and the error variances were low. In addition, the t-value of each item is given in Table 3.

Table 3 T-values for The Measurement Model

Items	t value	Items	t value
I1	5.76	I12	8.34
I2	13.63	I13	10.61
I3	12.98	I14	11.56
I4	7.83	I15	9.63
I5	8.59	I16	11.06
I6	10.86	I17	7.21
I7	14.86	I18	15.73
I8	8.85	I19	12.33
I9	17.05	I20	10.46
I10	8.85	I21	15.09
I11	7.17		

According to the t-values in Table 3, it was determined that the effect of all items on the factors was significant. Thus, a four-factor structure was confirmed with 21 items in the scale. According to the reliability analysis results, Cronbach's Alpha coefficient was determined as .840 for the first factor, .590 for the second factor, .627 for the third factor and .661 for the fourth factor. The total reliability analysis result was found to be .715. These values show that the scale is moderately and sufficiently reliable.

Perceived Teacher's Affective Support Scale

The scale developed by Sakız (2017) was used in this study. The scale was developed to determine the perceptions of students regarding the emotional support of the teacher. The validity and reliability studies of the scale prepared in Turkish form were conducted by Sakız (2017). Since this scale was used in the native language of the students, no adaptation study was conducted.

Construct Validity Study of Affective Support Scale. The measurement model of the confirmatory factor analysis is given in Figure 2.

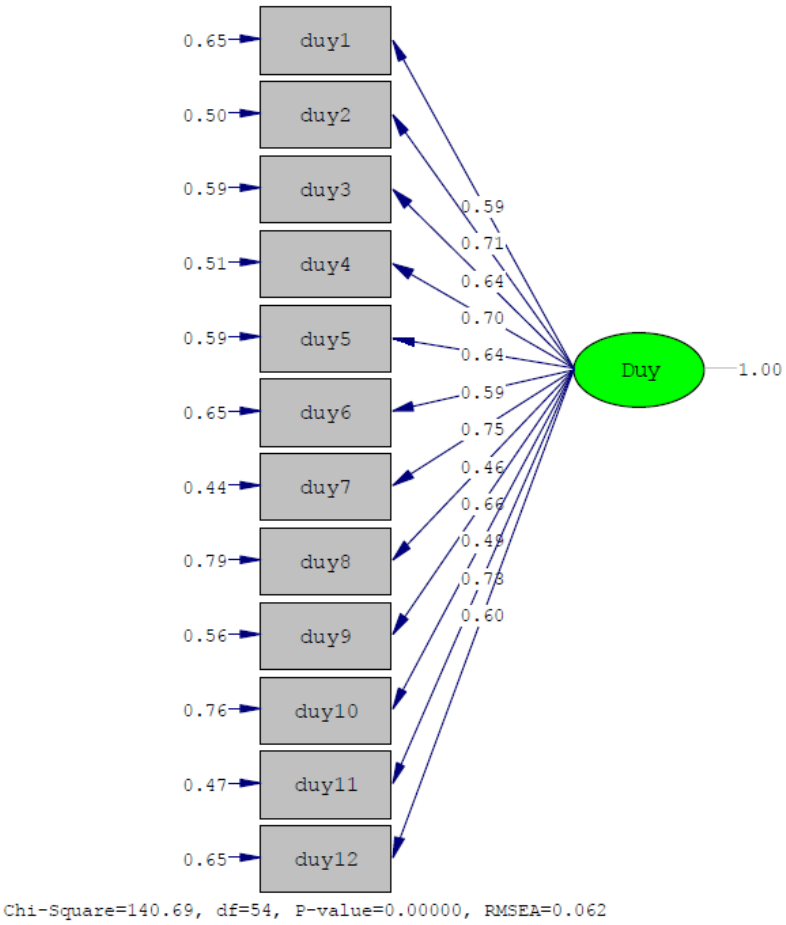

Figure 2 Confirmatory Factor Analysis Results of Affective Support Scale

According to Figure 2, χ^2=140.69 and sd=54, and the data show a perfect fit with χ^2⁄sd=2.61 (Çokluk et al., 2010). It was observed that RMSEA produced good fit with a value of 0.062; GFI produced excellent fit with a value of 0.95; SRMR produced excellent fit with a value of 0.04 and less than 0.05; CFI produced excellent fit values with a value of 0.98 and NNFI produced excellent fit values with a value of 0.98 and greater than 0.95 (Çokluk et al., 2010). In the confirmatory factor analysis (CFA), it was determined that the fit indices related to the measurement model were appropriate. It was determined that the standardised loadings in the measurement model were high, and the error variances were low. When the t values in the model were analysed, it was found that all items were significant for the scale. The reliability analysis result in the current study was found to be 0.88. The scale consists of 12 items in total and is given in a five-point Likert type.

Data collection

Both scales were given to the students simultaneously, and they were asked to fill out the scales by reflecting their real feelings. The scale was administered in the mathematics class. The mathematics teachers were present when the scale was administered in class. The students were told to think about their mathematics teachers while filling out the scales. It was especially stated that teachers would not see the answers given to the questionnaires, and the questionnaires would be mixed while collecting them. It was also emphasised that personal information would not be included in the questionnaires. The data were collected at the end of the first semester in January so that the students could get to know their teachers sufficiently. The students completed the questionnaires within 15 minutes at most.

Data Analysis

This study aims to determine the effect of perceived affective support on perceived adaptive support and examine the two forms of support in terms of different variables. Missing data analysis was performed for both scales, and it was determined that the missing data were randomly distributed. Then, the missing data assignment process was carried out using the series averages method. When outlier analyses were performed, it was decided not to remove any data from the data set. Since the adaptive support scale was different from the native languages of the students, a scale adaptation study was carried out. In the scale adaptation study for the adaptive support scale, exploratory factor analysis with SPSS software and confirmatory factor analysis with linear structural relation (LISREL) software were performed. Since the affective support was prepared in the students' mother tongue, confirmatory analyses were carried out using only LISREL software. All results were shared in the data collection tools. The effect of affective support on adaptive support was explained by structural equation modelling using the LISREL programme.

In order to perform variance analyses related to the data analysis of the study, kurtosis and skewness values were examined in the normality analyses of the two scales and it was determined that the Skewness value of adaptive support was -0.162 and the Kurtosis value was 0.436. The skewness value of affective support was -1.148 and the Kurtosis value was 1.623. The fact that these values are between +2 and -2 indicates that the data are distributed. In the analyses, the assumption of equality of variances was ensured. For the multivariate analysis of variance (MANOVA) test, the Box M test was found to be 8.467 and the p-value was found to be .592 in the analysis according to gender. In the analysis according to grade

level, the Box M test was found to be 37.930, and the p-value was found to be .170. According to this test, the data can be considered suitable for MANOVA analysis. Thus, the demographic information of the students regarding the adaptive and affective support scores was examined with the parametric tests, which are t-test, analysis of variance (ANOVA) and MANOVA in the SPSS program.

Results

The structural equation model for the study question "Do secondary school students' perceptions of affective support affect their perceptions of adaptive support provided by mathematics teachers?" is given in Figure 3.

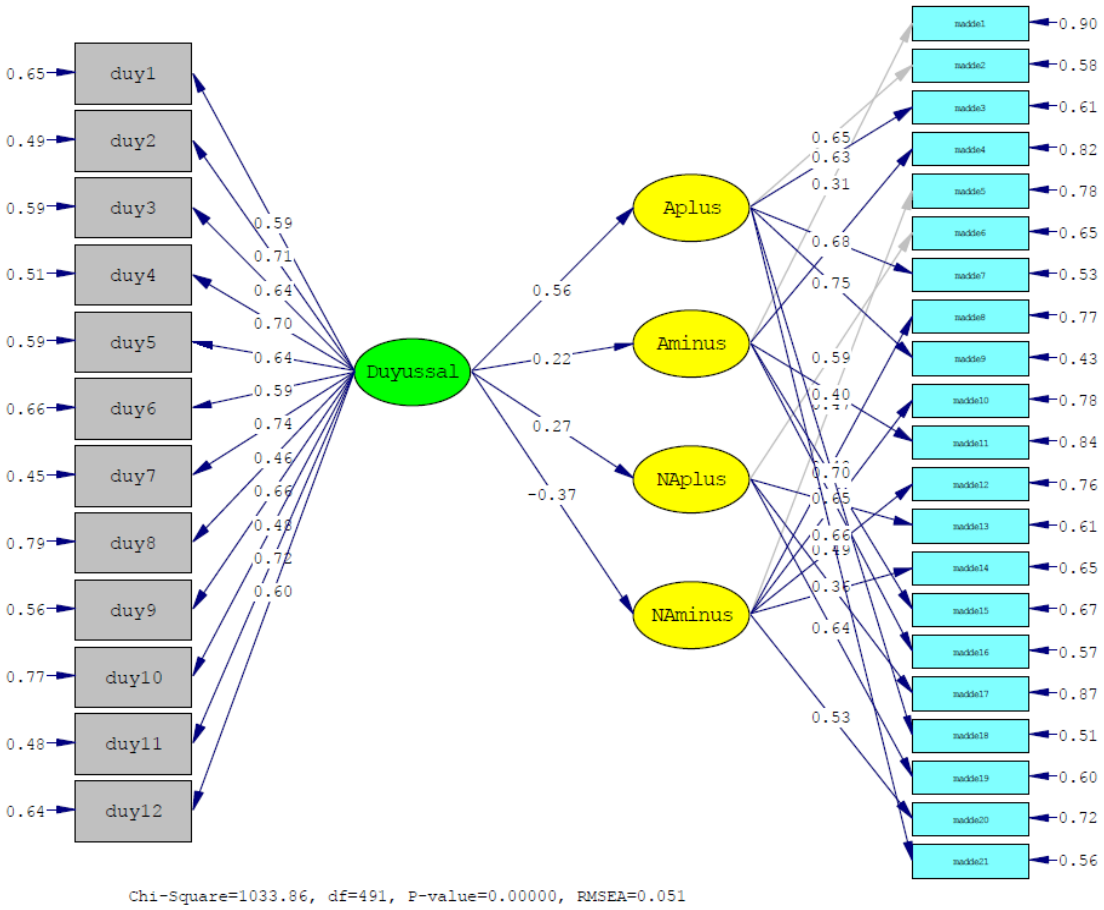

Figure 3 Structural Equation Model of Affective Support and Adaptive Support

According to the fit values given in Figure 3, it was determined that the data produced good fit values with the tested model, χ^2/df=2.10; RMSEA=0.051; CFI=0.95 NNFI=0.94

SRMR=0.07. In the structural model, the effect of affective support on adaptive support was significant in all sub-dimensions. While affective support is positively related to adaptive support types, it is negatively related to non-adaptive support types. It was concluded that affective support had the highest effect on the adaptive support sub-dimension, which includes more teacher regulation based on low student understanding. In this context, it was determined that the explained variance was 0.31. In this case, the students who receive affective support perceive receiving more adaptive support.

MANOVA results related to the study question "Do secondary school students' perceptions of adaptive support provided by mathematics teachers differ depending on gender?" are presented in Table 4.

Table 4 The MANOVA Results for Students' Adaptive Support Mean Scores by Gender

Factor	Gender	*f*	x̄	SD	F	p
A+	Female	217	24.84	5.47	1.566	.212
	Male	203	24.18	5.36		
A-	Female	217	15.67	4.04	2.303	.130
	Male	203	15.06	4.14		
NA+	Female	217	14.07	3.38	1.949	.163
	Male	203	13.58	3.76		
NA-	Female	217	14.18	4.59	0.496	.482
	Male	203	14.49	4.66		

Note. Wilk's Lambda (λ)=0.988, F(4, 415) = 1.218, p>.05, η^2=0.012

As a result of the analysis, no significant difference was found in the combined dependent variables according to gender, Wilk's Lambda (λ)=0.988, F(4, 415) = 1.218, p>.05, η^2=0.012. When the results for the dependent variables were analysed separately, no statistically significant result was found for any dependent variable depending on gender.

MANOVA results related to the study question "Do secondary school students' perceptions of adaptive support provided by mathematics teachers differ depending on grade level?" are presented in Table 5.

Table 5 The MANOVA Results for Students' Adaptive Support Mean Scores by Grade Level

Factor	Grade Level	*f*	x̄	SD	F	p	Tukey
A+	5	91	24.30	5.53	2.349	.072	
	6	132	25.53	5.01			
	7	121	23.91	4.93			
	8	77	24.01	6.41			
A-	5	91	15.52	4.48	0.548	.650	
	6	132	15.02	4.14			

	7	121	15.44	3.68			
	8	77	15.70	4.13			
NA+	5	91	13.91	3.56	0.383	.765	
	6	132	14.07	3.52			
	7	121	13.65	3.36			
	8	77	13.65	4.01			
NA-	5	91	13.87	4.94	4.762	.003	7>6
	6	132	13.37	4.51			8>6
	7	121	15.23	4.36			
	8	77	15.21	4.57			

Note. Wilk's Lambda (λ)=0.952, F(4, 414) = 1.719, p<.05, η^2=0.016, 6: sixth grade students, 7: seventh grade students, 8: eighth grade students.

According to Table 5, as a result of the analysis, a significant difference was found in the combined dependent variables according to the grade level, Wilk's Lambda (λ)=0.952, F(4, 414) = 1.719, p<.05, η^2=0.016. When the results for the dependent variables were analysed separately, a statistically significant difference was found for the NA- dependent variable depending on the grade level. When the source of this difference was analysed, it was found that students in upper grades received less adaptive support than students in lower grades. This shows that students in the upper grades perceive that the teacher provides less adaptive support for low student achievement.

The t-test results related to the study question "Do secondary school students' perceptions of affective support provided by mathematics teachers differ depending on gender?" are given in Table 6.

Table 6 The t-test Results for Students' Affective Support Mean Scores by Gender

	f	x̄	SD	t	df	p
Female	217	50.46	7.47	2.392	418	.017
Male	203	48.55	8.82			

As seen in Table 6, the mean scores of female students regarding affective support were 50.46 and the mean scores of male students were 48.55. According to the t-test result, the difference between these means was found to be significant, t(418)=2.392, p<.05. It was found that the mean scores of female students regarding affective support were significantly higher than the mean scores of male students.

ANOVA results related to the study question "Do secondary school students' perceptions of affective support provided by mathematics teachers differ depending on grade level?" are presented in Tables 7 and 8.

Table 7 Descriptive Analysis for Students' Affective Support Mean Scores by Grade Level

Grade Level	N	$\bar{x}$	SD	SE
5	91	51.68	7.01	0.74
6	132	52.27	6.69	0.58
7	121	46.36	8.28	0.75
8	77	47.18	9.38	1.10

According to Table 7, the mean scores of fifth grade students on the affective support scale were $\bar{x}$ =51.68, sixth grade students were $\bar{x}$ =52.27, seventh grade students were $\bar{x}$ =46.36 and eighth grade students were $\bar{x}$ =47.18.

Table 8 The ANOVA Results for Students' Affective Support Mean Scores by Grade Level

	Sum of Squares	df	Mean Square	F	p	Tukey
Between Groups	3056.217	3	1018.739	16.863	.000	5>7 5>8
Within Groups	25191.585	417	60.411			6>7 6>8
Total	28247.802	420				

Note. 5: fifth grade students, 6: sixth grade students, 7: seventh grade students, 8: eighth grade students.

According to Table 8, there was a significant difference in the mean scores of secondary school students regarding the affective support provided by the teacher by the grade level, $F(3, 420) = 16.863$, $p<.001$. Tukey test was conducted to determine which groups this difference originated in, and it was determined that eighth and seventh grade students had lower affective support scores than fifth and sixth grade students. It was concluded that the learning environment was perceived more positively in lower grades.

Discussion

In this study, students' perceptions of adaptive and affective support were analysed in terms of both the relationship between them and demographic variables. When the structural model is analysed, affective support has a direct and significant relationship with adaptive support. As a result, in affective supportive environments, students think that they receive cognitive support that is compatible with their learning. These results revealed that affective support positively affects the perception of adaptive support. Considering that affective support positively affects variables such as mathematics achievement, lesson participation, attitude, and self-efficacy (Kaya, 2020; Sakız, 2017; Wilkins & Ma, 2003; Yang et al., 2021), the result obtained is consistent with previous theories and supports the literature. These results suggest that creating learning environments where students are affective supported can

lead to positive results in adaptive support. Considering that teacher support positively affects students' mathematics participation (Liu et al., 2018) and achievement (Masinading & Gaylo, 2022) and reduces negative behaviours (Wang & Eccles, 2012), the importance of affective support increases. In addition, in a study examining the effect in the opposite direction, it was found that teachers who cognitively harmonised with students were perceived to be more likeable and friendly in affective terms (Fauth et al., 2014).

According to the results of demographic variables, it was determined that students' perceptions of adaptive support were independent of gender. Pol et al. (2022) also determined a similar result. In studies examining teacher support, students' mathematics achievements do not differ by gender (Dagoc & Tan, 2018; Wang et al., 2020). This result may be because teachers' adaptive support does not differ by gender. Regarding grade level, a significant difference was found in one of the sub-factors of adaptive support, "support with very little teacher regulation based on low student understanding". In this context, it was observed that students in upper grades perceived that the teacher provided less adaptive support to students with low achievement. This situation can be explained by the increase in students' perceptions that teacher support decreases due to the decrease in affective support based on the structural model. Studies have also stated that in the years following the transition to secondary school, students' perceptions of teacher support declined (Lazarides et al., 2019; Rice et al., 2012; Wit et al., 2010). According to Eccles and Roeser (2009), the decline in teacher support may be linked to students' decreased academic interest after transitioning to upper grades. This might be due to the new organizational structures (i.e., attendance) that hinder close relationships between students and teachers (Wit et al., 2010). However, according to Tao et al. (2022), teacher support had a stronger impact on upper-secondary students than lower-upper and elementary students due to high-stakes testing and accountability in upper-secondary schools.

For the perceived affective support, it was found that there was a significant difference according to both gender and grade level of the students. Regarding gender, it was determined that female students perceived affective support more positively than male students. Various studies have found that in some regions, girls perceive learning environments more positively than boys (Fusco, 2008), while in some regions, boys perceive more affective support than girls (Kim et al., 2000). As Sakız (2017) stated, this situation can be associated with cultural differences. There are findings that perceived affective support decreases in the upper grades. In this context, it can be claimed that the learning environment is perceived more positively in smaller classes. These results are also supported by the studies of Demaray and Malecki

(2002) and Rice et al. (2012). Demaray and Malecki (2002) and Rice et al. (2012) found that primary school students perceived support more positively than secondary and high school students. In this study, this difference was found between the fifth and upper grades for secondary school students. Thus, this study analyses and extends the results of previous studies in more depth.

Conclusions and Suggestion

Perceived teacher support positively affects mathematics achievement. So, defining the concept of perceived teacher support is important. This study identifies the factors contributing to teacher adaptive support in mathematical classrooms. Based on the results, there is a significant correlation between affective support and adaptive support. In addition, it was determined that students' perceptions of adaptive support were independent of gender. In terms of grade level, it was observed that students in higher grades perceived that the teacher provided less adaptive support to students. There was a significant difference in perceived affective support based on both the gender and grade level of the students. It may be important to encourage teachers to eliminate gender and grade level differences in terms of affective support because a significant part of students' perceptions that they receive adaptive support are explained by affective support. It is thought that increases in perceived affective support will positively affect adaptive support. Therefore, corrective measures can be taken for students' perceptions of support at gender and grade level. The teacher factor is important in supporting students in mathematics classes, and it is recommended that studies on teachers' perceptions of supporting students should also be conducted. One limitation of this study is that students' perceptions of support were measured rather than actual support. Differences may occur between students' perceptions of support and actual support scores. It may be interesting to analyse the study questions with actual support scores and compare them with perceived support scores. Moreover, the study comprises numerical outcomes, and upcoming studies can explore this matter from a qualitative perspective.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

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CRediT author statement

The study was single authored and the whole process was carried out by the corresponding author.

Research involving Human Participants and/or Animals

The study involves human participants. Ethics committee permission was obtained from Erzincan Binali Yıldırım University, Educational Sciences Ethics Committee. (Reference number: E88012460-050.01.04-244148; Date: 28/02/2023).

Ortaokul Öğrencilerinin Bakış Açısından Matematik Öğretmenlerinin Uyarlamalı ve Duyuşsal Desteği

Özet:

Bu araştırmada matematik derslerinde öğrenciler tarafından algılanan duyuşsal desteğin uyarlanabilir desteğe etkisinin ve her iki destek biçiminin bazı değişkenler açısından incelenmesi amaçlanmıştır. Bu araştırmada korelasyonel araştırma yöntemi kullanılmıştır. Çalışma ortaokul öğrencileri ile yürütülmüştür. Uyarlanabilir destek ve duyuşsal destek algısını ölçen iki adet ölçek kullanılmıştır. Öğrencilerin destek algıları arasındaki ilişki bir yapısal eşitlik modeli ile açıklanmıştır. Elde edilen sonuçlara göre duyuşsal destek uyarlanabilir destek ile doğrudan ve anlamlı bir ilişki içindedir. Ayrıca öğrencilerin uyarlamalı destek algılarının cinsiyet değişkeninden bağımsız olduğu tespit edilmiştir. Sınıf seviyesi açısından bakıldığında, üst sınıflarda bulunan öğrencilerin öğretmenin düşük başarıya sahip öğrencilere daha az uyarlanabilir destek verdiği algısına sahip oldukları görülmüştür. Algılanan duyuşsal destek için ise öğrencilerin hem cinsiyete hem de sınıf düzeyine göre anlamlı farklılık olduğu tespit edilmiştir.

Anahtar kelimeler: Uyarlamalı destek, duyuşsal destek, öğrenci algısı.

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Research Article

Being a Mathematics Teacher at Schools at Temporary Accommodation Centers: Turkish Teachers and Syrian Students

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Abstract – In the study, the difficulties faced by mathematics teachers at schools at Temporary Accommodation Centers in Türkiye and their ways of coping were investigated. In this sense, the study focused on the experiences of mathematics teachers working at the schools at the Temporary Accommodation Center, and it was aimed to contribute to the understanding of the teaching processes. The study data were collected from mathematics teachers working at schools at Temporary Accommodation Centers. The research was conducted with a qualitative approach. Phenomenology design was used in the study. The study observed that teachers try to create opportunities to learn mathematics. Teachers were attempting to enrich the lessons (ethnomathematics) by incorporating cultures and languages of refugee students into the class, even though they had not yet received any training. It was determined that living at a temporary accommodation center was an unfavorable language-learning environment, which hurt mathematics learning.

Key words: mathematics teaching, mathematics teacher, refugee student, Temporary Accommodation Center.

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Introduction

Recently, issues such as immigrants, refugees, and integration are essential on the world agenda. The increase in the number of displaced people can also be considered one of the reasons for this situation. With the increase in the number of refugees in the world, the number of refugees living in host countries has also increased, and this increase has brought with it many problems. Some of the issues that arise are refugees' social and cultural differences and the fact that they speak different languages (Harrison et al., 2019; Hokkinen

& Barner-Rasmussen, 2023). This situation makes refugee integration difficult, and countries take various measures to that aim.

The number of refugees in countries is directly related to that country's policies. Due to the internal turmoil in Syria in 2011, the neighboring country Türkiye followed an open-door policy to Syrian citizens, and the number of refugees in Türkiye increased unpredictably (Bayır & Aksu, 2020). According to the United Nations Refugee Agency (UNCHR) 2022 data, with 3 million 800 thousand refugees, Türkiye has the highest number of refugees in the world. According to the same data, 54% of Syrian refugees are in Türkiye (UNCHR, 2022). In the first stage, refugees living at Temporary Accommodation Centers were supported to continue their lives outside the temporary shelter centers to increase their social cohesion when the time to return to their countries was prolonged. Thus, refugees could live all over Türkiye, especially in city centers. However, not all Temporary Accommodation Centers have been closed, and currently there are 9 Temporary Accommodation Centers in 7 provinces in Türkiye. According to the data of the T.R. General Directorate of Migration Management on June 8, 2023, the number of Syrians staying at temporary accommodation centers is 61 thousand 441 (T.R. General Directorate of Migration Management, 2023).

Along with the increase in refugees in Türkiye, regulations were made in the field of education as well as in every other area, and refugee students, who were educated in Temporary Accommodation Centers, were gradually placed in schools affiliated with the Ministry of National Education of Türkiye as of 2016, with the arrangements made. However, since not all Temporary Accommodation Centers were closed, the schools here continued their education under Ministry of National Education of Türkiye. The Temporary Accommodation Centers provide educational services for school-age children, adult education services, health services at the same standards as Turkish citizens, places of worship, markets, and many other opportunities (T.R. General Directorate of Migration Management, 2022). All education services, including preschool education, are provided to school-age children at temporary accommodation centers.

Immigrant Education

Curriculum designed to support the education needs of immigrant students depends on the effectiveness of the teachers who implement them (Borjian & Padilla, 2010). The effectiveness of teachers is related to how they see their students and accept themselves as agents of change (Olsen, 1997; Valdes, 1998; Valenzuela, 1999). In this sense, providing

professional support to teachers with immigrant students is essential in increasing teacher proficiency and improving education in classes with immigrant students (Souto-Manning, 2013).

Some studies on the education of immigrant students suggest that teacher capacities should be increased so that teachers can see students as gifted learners, encourage rigorous learning environments, and meet their academic needs (Elfers et al., 2013; Liggett, 2010; Scanlan & López, 2015; Villavicencio et al., 2021). However, there is a lack of information about how teachers should be supported (Lowenhaupt, 2015). It is essential to examine the experiences and teaching processes of teachers who are refugee students in order to eliminate the lack of knowledge.

As in other countries, studies have been conducted on teachers with refugee students at public schools in Türkiye. In their study, Yenilmez and Çöplü (2019) found that teachers' main difficulties in educating refugee students was the students' need to learn Turkish and understand the lesson. Erdem (2017) states that teachers struggle with materials while teaching immigrant students. Textbooks are primarily used in lessons, but since they are prepared with Turkish students in mind, they create a deficiency for immigrant students. Şimşir and Dilmaç (2018) determined that immigrant students have problems understanding the lesson, doing homework, reading and writing, and using different curricula. İmamoğlu and Çalışkan (2017) found that international students also distract other students in the lesson because they have language problems. When the studies were examined, it was seen that not knowing the language was influential based on the difficulties encountered.

Immigrant students were given intensive Turkish lessons by the Ministry of National Education within the scope of modules created by the General Directorate of Lifelong Learning, projects implemented (Supporting the Integration of Syrian Children into the Turkish Education System (PICTES) project) and additional Turkish lessons taken from Public Education Centers (İşigüzel & Baldık, 2019). However, studies show that it takes time for Syrian students to adapt to education (Alpaydın, 2017; Dere & Demirci, 2023; Topçu et al., 2019). Compared to other courses, it is thought that the mathematics course having a universal language and using common symbols around the world will be an advantage in teaching mathematics to refugees. However, many teachers think teaching mathematics to immigrant students can be challenging (Bahadır, 2021). In the study conducted by Yolcu and Doğan (2022) with 83 mathematics teachers teaching at multicultural classrooms, it was determined that the teachers argued that the first condition of teaching mathematics to

immigrant students was to have a command of the local language. In the study of Kılıç (2020), mathematical words in mathematics education and communication with refugee students, the use of visuals and drawings to ensure communication, the use of gestures and mimics, the inclusion of refugee students in classroom activities, etc., suggested. The author stated that the cultural incompatibility of the students in the lesson should be minimized by carrying out activities suitable for their subjects by the teachers.

Offering a learning environment to every immigrant student studying in multicultural classrooms is realized by accepting the existing cultural diversity as a positive resource (Celedón-Pattichis et al., 2018). Gutstein and Peterson (2006, p. 3) stated that teachers should see students' native cultures and languages as strengths to build on rather than a deficiency that needs to be compensated. Thus, teachers know their students and their differences and reflect cultural diversity in the classroom as a favorable situation with multiple mathematics applications for all students (de Abreu, 2014). However, studies on classrooms with cultures that are entirely different from the culture of the teacher are limited. The experience of Turkish mathematics teachers, who teach a different culture at Temporary Accommodation Centers, is essential in understanding the teaching process and designing an ideal learning environment.

Therefore, mathematics teaching experiences in classes where all Turkish mathematics teachers are immigrants arouse curiosity. When the literature was examined, it was seen that the studies were carried out with the teachers at multicultural public schools where Turkish students and immigrant students take lessons together. This study differs from other studies in that it includes mathematics teachers working at schools at Temporary Accommodation Centers. Contrary to the disadvantageous situations experienced in the language learning process, mathematics is valuable because it provides an environment where language-independent refugee students can express themselves and reflect their potential in schools thanks to its universal aspect (Bahadır, 2021).

One of the 9 Temporary Accommodation Centers in Türkiye is in the province where the study was conducted. The study was carried out with 3 mathematics teachers working at the Temporary Accommodation Center in this province. According to the data of the Republic of Türkiye, Directorate General of Migration Management, dated 2023, the city with the highest density of Syrians compared to the local population in Türkiye is the city where the study was conducted, with 33.62% (T.R. Directorate General of Migration Management,

2023). These statistics are important as they show the refugee density of the region in Türkiye where this research was conducted. In the research, the term refugee was used to describe the Syrian individuals who had to emigrate from their country due to internal turmoil. This study aimed to reveal the mathematics teaching process from the perspective of mathematics teachers working at schools in Temporary Accommodation Centers in Türkiye. Based on the teachers' experiences, the study would make an effort to describe mathematics teaching process.

Method

The study was planned and carried out with a qualitative research approach. The reason for this was the fact that qualitative research is sensitive to the natural environment, has a holistic understanding, reveals the perceptions of the participants, and the researcher also has a participatory role (Yıldırım & Şimşek, 2008). The study was a phenomenological research since it focused on mathematics teachers' experiences regarding the refugee student phenomenon. In the phenomenology design, it is essential to interpret and define the phenomenon based on the people's experiences (Jasper, 1994). In such a study, the phenomenon is defined, data is collected from experienced people, and a holistic description is presented (Creswell, 2013). Finally, the research aimed to reveal the paths that mathematics teachers follow in the education process of immigrant children, their perceptions of themselves in this process, their efforts and the parts they struggle with. In this respect, it was in the category of descriptive phenomenological research.

Participants

The study group of this research consisted of 3 Turkish mathematics teachers (whose students are all immigrants) who worked at the temporary accommodation center, where Syrian immigrants live the most, and participate in the study voluntarily. Purposeful sampling was used because only mathematics teachers working at the temporary accommodation center were selected for the study. The demographic information of the interviewed teachers is given in Table 1.

Table 1 Demographic Information of Participants

Teachers	Seniority	Gender	Graduation	Level Taught
T1	1	Female	Undergraduate	Secondary School
T2	1	Female	Undergraduate	Secondary School
T3	2	Male	Graduate	High School

Data collection

Qualitative data were used in the research, and the data were collected through semi-structured interviews. The researcher created interview questions as a result of field scanning and finalized using expert opinions for content validity. Two experts' field of study was on the education of migrant children. Along with the pilot interviews, two more questions were added to the interview questions shaped by expert opinions. Pilot interviews were held with 2 teachers working at the temporary accommodation center. The interview questions, which took their final form at the end of the pilot study, consisted of 17 open-ended questions. The prepared questions mostly aimed to reveal the difficulties, conveniences, differences and recommendations that teachers experience in mathematics teaching processes. Necessary permissions were obtained before the data were collected. The interviews were carried out in empty classrooms within the school, coinciding with the hours when the teachers did not have classes. In order to avoid data loss, voice recorders were used, and permission was obtained from the teachers. The researcher took extra notes where necessary. The interviews were conducted in a casual atmosphere, and the teachers were not shown a restrictive attitude. While conducting the interviews, the questions were asked to the teachers in the same order, and the interviews were completed by asking additional questions depending on the answers from the teachers. Each interview lasted an average of 35 minutes. The records were written in order to analyze the data in the interviews.

Data Analysis

Data were analyzed using content analysis method. The main goal of content analysis is to reach concepts and relationships that can make sense of the data obtained (Tekin-Karagöz, 2014). The obtained data were analyzed separately by the researcher and an expert. The expert was working in qualitative research and gave postgraduate courses on qualitative data analysis. The results of the two analyzes were compared, and a consensus was reached on each finding. While analyzing the data, first, codes were created. Secondly, some codes were combined, limited and simplified. A different expert's opinion was taken for the findings that could not be reconciled, and a conclusion was reached. Thus, the reliability of the study was increased. In addition, to increase the validity and reliability of the research, all stages were explained step by step in a transparent manner. Finally, the codes created based on the data gathered under themes.

In order to ensure internal validity, the researcher and an expert used the triangulation analyst's strategy (Patton, 2000, p. 560) to independently analyze the data set, which was finalized as a result of the coding and sorting phase and compared the analysis results.

In the study, a different expert who has knowledge of mathematics and similar studies was determined. Then, the text file that contain the three themes created as a result of the analyzes and their explanations, and the file that contain the answers of the working group were sent to the expert. In this direction, the expert was asked to compare the answers of the study group with the three themes and match them in such a way that no student was left out. The feedback received after the matching and the themes created by the researcher and the expert (the expert who analyzed with the researcher) were compared according to the formula developed by Miles and Huberman (1994, p. 64). Reliability = (Agreement) / (Agreement + Disagreement)

The consistency between the coders was calculated with the formula (1). According to the formula developed by Miles and Huberman (1994, p. 64), the calculated value was 92%. In this context, it could be noted that the study was reliable. The analysis framework of the study is given in Table 2.

Table 2 Analysis framework of the study

Themes	Description	Code	Description
Mathematical Focus	Challenges of, awareness, and recommendations for the mathematics teaching process	ethnomathematics	Efforts to create fair mathematics learning environments in the mathematics teaching process
		the language of mathematics	Expressions of universal symbols of mathematics accepted all over the world
		structure of math topics	Content structures of the topics covered in the mathematics lesson. Verbal or symbol-based expressions
		structure of language	Differences in writing styles of Turkish and Arabic languages, the effect of fonts starting from the right or starting from the left on mathematics
		mathematical achievement	Refugee students' performance in mathematics
		materials	Equipment supports in the school's mathematics teaching process
Classroom Management	Planning and implementation of the mathematics teaching process	culture	Perspectives of Syrian refugees on education and teachers stemming from their own culture
		life conditions	Living conditions of refugees at the Temporary Accommodation
Psychological Process	Teachers' emotions in the	satisfaction	Teachers' sense of professional satisfaction
		the feelings of failure and inadequacy	Teachers' perceptions of themselves during the teaching process

mathematics teaching process	source of motivation	The situations that motivate teachers in the process of teaching mathematics to refugees

Ethical Procedures

This study was found suitable to research and publish according to the decisions taken with the letter numbered 12101 at the meeting of the Social and Human Sciences Ethics Committee of Kilis 7 Aralık University, dated 10.11.2022, and numbered E-76062934-044.

Findings and Discussions

The research data were examined, and it was seen that three categories were formed as a result of the analysis. These categories were the mathematical focus, classroom management, and psychological process. These categories were also divided into codes within themselves. Mathematical focus was gathered under five codes as ethnomathematics, the language of mathematics, the structure of mathematics subjects, the structure of language, and mathematical success. Classroom management was grouped under two codes: culture and living conditions. Psychological process was grouped under three codes: satisfaction, source of motivation, and feeling of failure-inadequacy.

Mathematical Focus

Mathematical focus was gathered under five codes as ethnomathematics, the language of mathematics, the structure of mathematics subjects, the structure of language, and mathematical success.

Ethnomathematics

All teachers stated that they did not receive any training for immigrants. Despite this, the high school mathematics teacher who was interviewed stated that he sometimes tried to emphasize the cultures of his students in the subject teaching part and the question solution part. He expressed that they were interested in the lesson and that this situation pleased them, albeit slightly. A part of the interview with T3 is below.

Researcher: You mentioned that you did not receive any education, but what changes have you made to teaching mathematics to immigrant students?

T3: It is very suitable to adapt some subjects to their culture. For example, when I talk about ratio, I start with their food, they give the recipe, and I emphasize the ratio in the recipes.

Two middle school mathematics teachers who were interviewed stated they did not emphasize students' culture and they were born in Türkiye because they were secondary school students. A part of the interview with T1 is below.

T1: Secondary school students need to learn either Turkish or Syrian culture. They are foreign to Syrian culture because they were not born in Syria; they are foreigners to Turkish culture because they live in a temporary shelter. However, since they speak Arabic at home, they try to speak Arabic in every environment, including school. That is why their Turkish needs to develop. We also sometimes express certain things with Arabic words out of necessity. For example, I use the word "taksim" when I want to say division.

As seen in the dialogue above, the teacher sometimes uses mathematical terms of Arabic origin.

The Language of Mathematics

All teachers stated that having a universal language in mathematics is an advantage compared to other courses, so the interview with a participant teacher is as follows.

T2: Although they are at a low success level, they like mathematics the most. Because when numbers are involved, their level of understanding increases more. Teachers of verbal lessons have a more challenging time than us. We can find something in common with numbers, albeit a little.

As seen in the dialogue above, he stated that mathematics attracts students' attention because it has a universal language and that mathematics is in an advantageous position compared to other lessons.

Structure of Math Topics

All teachers stated that since the mathematics lesson was not just about numbers, students get disconnected from the lesson, especially when problems based on verbal understanding were involved. They stated that they used numbers more while giving basic information at a superficial level depending on the subject of the mathematics course. However, they stated that they had difficulties in some subjects. A part of the interview with the participant teacher is given below.

T3: I need help explaining the subject of clusters. We already set the curriculum. This school has such a nice practice. At the beginning of the year, we prepare a mathematics curriculum for each level according to the level of the students and submit it to the school

administration. It is not possible to give mathematics teaching plans in public schools here. I teach in high school, but most of my students are at the elementary level. So I needed help getting my students to comprehend the concept of the cluster. Therefore, I did not include the subject of clusters in my curriculum this year. It remains abstract according to students; they need more Turkish knowledge to concretize.

In the dialogue above, the teacher stated that they needed verbal expressions to embody the expression of some subjects that remained very abstract. However, the students needed help understanding this.

Structure of Language

Two secondary school teachers stated difficulties, especially in the division process. When asked the reason, they stated that it was due to the structure of languages. A part of the interview with T2 is given below.

Researcher: Why do you particularly have trouble with division?

T2: Because the structure of their language and ours are different, we divide the numbers starting from the left when dividing. According to our practice (in Turkish), the articles are written and read starting from the left. Since their language (Arabic) is written and read from the right, they try to start from the right when dividing. Therefore, we need help explaining them. Although it is essential, I need help solving the problem of partitioning.

As seen in the dialogue above, teachers had difficulties in the division process due to the structure of the Arabic and Turkish languages (starting from the right, starting from the left).

Mathematical Achievement

All of the teachers stated that the students' success was meager. Below is a part of the interview with T1:

T1: Even though we achieve a universal language with operations in mathematics, more is needed for success in mathematics. We are reaching a certain point, but more is needed. Language is one of many reasons. Students here have no goals. They have yet to grasp the importance of having a profession and reading. There are no good examples around. Mainly, very few people get a job by studying at the shelter and can set an example.

The teacher stated that, as seen in the dialogue, the students' mathematical achievements were generally low and that language was not the only reason. He stated that the other factors in their failure were the lack of goals of the students and the lack of good examples in their environment. He also mentioned that living in a temporary shelter affects them.

Materials

All the teachers stated that there were too many materials in their schools and that it was beneficial in explaining some subjects. A part of the interview with T3 is below.

T3: The school has some advantages indeed. For example, we have a large number of materials. Students are more interested in the lessons where we use materials. In this sense, I like the facility of the school. They are a lifesaver in some of the issues we have difficulty with.

As seen in the dialogue above, the teacher mentioned that the school's material facilities were good. He emphasized that students were more interested in the lessons in which materials are used. Other teachers, such as T3, also stated that the students were interested in the materials.

Classroom Management

Classroom management was grouped under two codes: culture and living conditions.

Culture

All of the teachers stated that they had problems in terms of classroom management. For example, two secondary school teachers, who were in the beginning of their profession, stated that they want to receive training in classroom management. In this sense, T3 felt having more advantages than secondary school teachers. A part of the interview with T3 is below.

T3: We have problems regarding classroom management in the 9th grade. However, when you go towards the 12th grade, this problem decreases. Because now they are slowly starting to adapt to our culture. They are starting to pay more attention to education. However, the job of secondary school teachers is challenging in this sense.

For example, I have only one expectation from parents. That is to leave my students alone. Because they want to marry female students at an early age, they want male students to work and earn money without studying. Unfortunately, these are the thoughts of our parents at

the temporary shelter. Without these, I am sure the students will be more willing to attend the lessons.

In the dialogue above, T3 mentioned that students adapt better to Turkish culture over time. He stated that their perspective on education gradually changed in a positive direction. He mentioned that the work of teachers at secondary school was difficult. In addition, the fact that female students get married early, and male students were required to work and earn money, the students' desire for lessons decreased. He stated that this was the parents' point of view at the temporary accommodation center.

A part of the interview with T1 is below.

Researcher: You stated that you felt inadequate. In what sense do you feel inadequate in mathematics lessons?

T1:Women are not valued in Syria. I see it better in this shelter. When we are female teachers, they do not take our words seriously. One of my students said that in our society, teachers are valued. So I asked why you do not value us. He fell silent and did not answer. Most of the time, mathematics is in the background anyway. So we emphasize the concept of respect rather than the concept of love.

In the dialogue above, the teacher stated that classroom management in mathematics lessons was adversely affected due to the Syrian culture.

Life Conditions

All teachers stated that the fact that families generally work in the fields at the temporary accommodation center affects classroom management. Teachers who stated they could not get parent support stated that this situation affected their mathematics achievement. A part of the interview with T2 is below.

T2: Families stay at the shelter because they want to benefit from the facilities (house, electricity, natural gas, …) provided by the state. Here, parents usually work in the fields. Students' families are often oppressive, but they do not use this attitude for school. Students are afraid of their families. Of course, we do not want to teach out of fear, but at least we want them to be respectful towards us in the lessons. There are interpreters at our school, but since the families work, we cannot communicate with the parents anyway; even if we call them, they do not come. Since the students' parents are working, we cannot even visit them.

Therefore, students do not listen to the lessons knowing that their families will not be informed, and they disrespect us. As they have the mentality that teachers cannot reach our family and tell them what we have done, they are disrespectful in the lessons. However, 2-3 students in each class are very respectful and focused on the lesson. However, when you consider that the class is 30-35 people, you will see how small this number is.

In the dialogue above, the teacher stated that although the students wanted to communicate with their families, they could not. He said that this was because the families were working. He stated that the students generally do not listen to the lesson because the teachers cannot communicate with the parents and the students disrespect them without hesitation.

Psychological Process

Psychological process was grouped under three codes: Satisfaction, Source of Motivation, and Feeling of Failure-Inadequacy.

Satisfaction

Two teachers said that they had professional burnout despite their first job. A part of the interview with T1 is below.

T1: Sometimes, I explain the subjects I teach in classes to the air. I need more professional satisfaction. There are 1 or 2 people who pay attention to the lesson in a class of 30-35 students. Others do not listen because some do not understand, and some are not keen on education. This upsets me a lot.

As seen in the dialogue above, the teacher stated that she could not get professional satisfaction by thinking that the students did not listen to the lesson and that what she said was wasted.

The Feeling of Failure and Inadequacy

Two teachers said that students see life as a temporary shelter. The teachers said this situation distracted the students from the lesson, so the students got poor exam scores. They stated that the general failure of the students created a feeling of inadequacy in themselves as mathematics teachers. However, T3 stated that there were gradual improvements in his students and that this made him happy, so he did not feel inadequate. A part of the interview with T2 is below.

T2: For example, our students take the entrance exam to high school in the 8th grade. However, even our best students need help getting into good schools. Sometimes I feel inadequate when 2-3 students in each class need help to get the result, I want from them. So there is a feeling of not being able to teach, which bothers me a lot.

As can be seen above, the teacher felt terrible that he could not teach mathematics. He thought this was the reason for the general failure of the students.

A part of the interview with T3 is below.

T3: I see that especially my senior students' interest in mathematics has gradually increased. That makes me happy. I was teaching addition and subtraction to these students, but now I am teaching polynomials and functions. Think about it; this is a beautiful thing. Yes, their level of success is low in general, but their interest is gradually increasing, which means their success in mathematics will gradually increase.

As can be seen, T3 does not have a feeling of inadequacy. However, he stated that because his students' interest in mathematics increased, this made him happy and that he did not have the feeling of inadequacy.

Source of Motivation

Two teachers stated that the most significant motivation sources were students. They stated that seeing the changes in students was an excellent source of happiness for them. A part of the interview with T3 is below.

T3: Although the students tire us, they are children. Due to war, they had to leave their country and come to another country. They need us. No matter what happens, we are educators; even if we are tired and sometimes even helpless, we must bring them to this country. We have to be the light for them. They are so innocent. My aunt was a teacher when I was appointed to this school for the first time. She told me, "You are an educator, you should do whatever your job is and you should not waste time with complaints. If you love your students very much, even if you get tired, you will forget all your tiredness with their smiles. Always do your job with passion." -I love my aunt very much; she is an excellent teacher, and I always took her as an example. Even though I am tired, I love my job. These words will always be a light to me.

In the above dialogue, T3 mentioned that as an educator, it was necessary to integrate students into society. He stated that children were very innocent, and this situation motivated

him. He mentioned that this situation also contributed to the advice he received from his family elders.

Conclusions and Suggestions

The study showed that mathematics teachers working at temporary accommodation centers had some advantages in terms of language. This advantage was based on the fact that mathematics is a universal language. Considering that the biggest problem of teaching immigrants was not speaking the language (Başar, Akan & Çiftçi, 2018; Gorgorió & Planas,2005; Nortvedt & Wiese, 2020; Yolcu & Doğan, 2022), this could be considered as a great advantage. However, it was determined that the common language they created with numbers constituted an advantage to a certain extent, and then there were problems caused by not speaking the language. This situation was compatible with the studies on teaching mathematics to immigrant students (Bahadır, 2021; Yenilmez & Çöplü, 2019; Yolcu & Doğan, 2022; Moschkovich, 2002). It was determined that it was difficult to teach mathematics to subjects that required more verbal expressions to understand. This showed that the universal language of mathematics was limited to numbers and formulas only.

Students whose first language is not the language of instruction have to learn certain forms of the language of mathematics through the classroom, although there is no specific support for this (Gorgorió & Planas, 2001). According to the findings, since there were no Turkish students to interact with at the temporary accommodation center, it could be argued that it was a disadvantageous environment in terms of understanding the language of mathematics. The fact that the students lived at the temporary accommodation center, the people around them were entirely Syrian, and the people only spoke Arabic among themselves made the language learning process difficult. Although there were translators and Turkish teachers, it was thought that the students at the temporary accommodation center had more difficulties in terms of language than the immigrants who did not live at the temporary accommodation center. This situation affected the mathematics course, which has a universal language like all courses.

Based on the study's findings, it was determined that teachers had difficulties teaching division, one of the basic mathematical skills. It was stated that this was due to the structure of the Arabic language. Arabic is a language that is written and read from the right. In division, the division is done by starting from the left of the number. Therefore, it was stated that the students tried to make operations starting from the right of the dividing number. When the literature was examined, it was seen that although Turkish is a language that is

written and read from the left, students learned to perform operations by starting from the right in addition, subtraction and multiplication. However, they applied the same rule in the division by generalizing the last division they learned. In their study, Varol and Kubanç (2015) found that the students started the division operation from the right by generalizing the right starting rule, valid in subtraction and multiplication operations, to the division operation. According to Reys et al. (1998), the division is difficult for students for various reasons. One of these reasons is that it starts from the left, not the right, like other operations. In other words, writing and reading languages from the right or left does not change the fact that students have difficulty in the division. However, it was thought that while the language of Syrian immigrants was written and read from the right, addition, subtraction and multiplication were done by starting from the right, and only the operations starting from the left in the division process were more complex for the students who read and write the language from the left.

It was observed that when teachers had problems caused by not speaking the language, they developed some strategies to solve them. For example, it was seen that they tried to make the lesson understandable by learning Arabic words, and at the same time, they taught the lessons by trying to emphasize their culture. This situation showed that teachers benefit from ethnomathematics to create opportunities to learn mathematics. This finding of the study was found to be positive in terms of teaching mathematics to immigrants. It was thought that benefiting from the cultures of immigrant students would contribute to associating mathematics with real life. Barwell (2009) stated that teachers should be aware of cultural and language issues and how they relate to mathematics teaching and learning. Bahadır (2021) stated that teaching immigrants using ethnomathematics would have positive results in terms of mathematics achievement and attitudes towards mathematics. The fact that teachers used ethnomathematics methods without any training may indicate teachers' efforts to teach mathematics. Rousseau and Tate (2003) identified mathematics teachers' views on equality as the main barrier to equitable teaching practices that give all students the best possible learning opportunities. The fact that teachers see all students as equal and ignore their cultural and individual differences can be seen as an injustice to both students and themselves. This situation causes students to miss the factors that prevent learning (Nortvedt & Wiese, 2020). It is essential that teachers adapt the subjects according to their students and give importance to cultural differences while teaching mathematics to immigrants. This study finding showed

that teachers had a fair perception towards the concept of equality to create learning opportunities.

It was seen that the feeling of inadequacy and inability to teach some teachers had been directly related to student failure. It was determined that teachers had negative feelings because they thought they spent more effort at this school than at regular schools and did not receive success in return. Teachers' mastery of these feelings in the first years of their duties was thought to affect their mathematics teaching processes negatively. The formation of this feeling was based on the fact that teachers were appointed to schools without receiving any training for immigrant students. It was considered that teachers would not feel so inadequate when they consider immigrant students as not unsuccessful but as disadvantaged due to their culture and living conditions. In order to create this awareness, the training given to the teachers for immigrant students would play an important role. Boos-Nünning et al. (2007) stated in their study that immigrant students should be regarded as bilingual individuals who will act as a bridge between cultures, superior to monolingual children. It was thought that this perspective should be taught to teachers.

All the teachers stated that they felt inadequate in classroom management. Some teachers stated that they wanted to receive training in this regard. When we the reasons of this situation were examined, it was seen that it was based on the cultural and living conditions of Syrian immigrants, especially the language problem. However, some studies (Akın, 2006; Alkan, 2007; İlgar, 2007; Sağlam, 2007; Erol, 2006; Terzi, 2001) revealed that as the experience of teachers increases, their classroom management skills also increase. The fact that the interviewed teachers were in the first years of their profession was thought to be another factor in their feeling of incompleteness in classroom management. Despite this, the adverse effects of culture and language insufficiency on classroom management should not be ignored. Due to the language problem, it is inevitable that immigrant students do not understand the lesson and turn to other distractions in the lesson. Studies have shown that teachers who teach immigrant students negatively assess themselves in terms of classroom management (Yenilmez & Çöplü, 2019; İmamoğlu & Çalışkan, 2017), a situation which shows parallels with the study.

All of the teachers stated that they did not receive parental support. A teacher stated that the only expectation from parents was to leave the children alone. In the findings of the study, it was revealed that the parents wanted their daughters to marry early, and their sons to work and earn money. It was argued that this situation was caused by the culture and the economic

situation they were in. Sarıtaş, Şahin, and Çatalbaş (2016) stated in their study that Syrian parents do not take care of their children, that the economic difficulties they experience negatively affect the children and that they also have difficulties in communicating due to language differences. These results were in agreement with the present study.

Considering the study findings, it was seen that the students were more compatible towards the last year of high school. This may indicate that as students' stay in Türkiye increases, cultural adaptation increases and language problems gradually disappear.

Research findings showed that the Ministry of National Education sent many materials specifically to accommodation center schools. Teachers stated that students' interest in lessons increased with materials. Teachers also stated that they stretched the mathematics curriculum a little more, taking into account the student's level. Taking these statements into consideration, it could be argued that the Ministry of National Education follows an appropriate strategy for the mathematics education of immigrant students.

Two teachers stated that the sources of motivation were students and the positive changes they observed in them. One teacher stated that the increase in students' interest in mathematics made him very happy. He stated that his motivation towards his work increased when he thought that his students might have experienced war trauma and that they were children. At the same time, he stated that one of his loved ones was an educator who said that he should do his job with love. The teacher said that he was very impressed by this statement. Experienced teachers who love the teaching profession would positively impact their professional experience and the scope of the teaching profession.

The number of immigrants in Türkiye has increased suddenly and rapidly in a certain period. It could be argued that this situation also causes problems in the education system. While teaching mathematics to immigrants, despite having a universal language, it was seen that problems were caused by needing to learn the language after a certain point. In particular, the fact that students speak Arabic among themselves and the absence of Turkish students was seen as a negative situation regarding language learning at schools at the shelter centers, where all students were immigrants. Although measures were taken to eliminate this situation (Turkish instructors and Arabic translators were available at this center), it was observed that there were problems arising from the need for more interaction with Turkish. The teachers' attempts to explain the lesson by emphasizing the culture while teaching mathematics or trying to explain the lesson by learning Arabic words were considered efforts to create

opportunities for learning mathematics. It could be considered a valid policy in mathematics teaching that the Ministry of National Education gives material (tools) aid to schools with immigrants. Considering the reality of immigrants in Türkiye, it was suggested that teacher training programs include information about immigrant education. In addition, in-service training for immigrant education should be suggested to increase effectiveness of teachers employed at the temporary accommodation center and their professional satisfaction. Finally, it was recommended to carry out studies with more participants by removing the study's limitations.

Limitations of the Research

Current research has some limitations. This study was conducted with three teachers working at the temporary accommodation center. This was a mandatory choice as the temporary accommodation center has a limited number of math teachers. All interviewed teachers had their first teaching experience in these schools and were in the first years of their teaching profession. Since the first years of the teaching profession are the years of learning and experiencing the profession, interviewing teachers who have no experience in the study requires a discussion of the results in a specific context. Therefore, there is a generalizability problem in comparisons. Despite these limitations, the mathematics teachers' experiences working at the temporary accommodation center were tried to be described. The study will inspire and provide resources for other researchers focusing on mathematics education at temporary accommodation centers.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

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CRediT author statement

The study was single authored and the whole process was carried out by the corresponding author.

Research involving Human Participants and/or Animals

The study involved human participants. Ethics committee permission (Date: 10.11.2022, Number: E-76062934-12101) was obtained from Kilis 7 Aralık University, Social and Human Sciences Research Ethics Committee.

Geçici Barınma Merkezindeki Okullarda Matematik Öğretmeni Olmak: Türk Öğretmenler ve Suriyeli Öğrenciler

Özet:

Çalışmada, Türkiye'de Geçici Barınma Merkezi'ndeki okullarda matematik öğretmenlerinin karşılaştığı zorluklar ve başa çıkma yolları araştırmıştır. Bu anlamda Geçici Barınma Merkezi'ndeki okullarda görev yapan matematik öğretmenlerinin deneyimlerine odaklanılmış ve öğretim süreçlerinin anlaşılmasına katkı sunmak amaçlanmıştır. Çalışmanın verileri Kilis ilinde bulunan Geçici Barınma Merkez'lerindeki okullarda görev yapan matematik öğretmenlerinden toplanmıştır. Araştırma nitel bir yaklaşımla planlanmış ve yürütülmüştür. Çalışma matematik öğretmenlerinin mülteci öğrenci olgusuna ilişkin deneyimlerine odaklandığı için fenomenolojik bir araştırmadır. Araştırmada mesleklerinin ilk yıllarında olduğu tespit edilen öğretmenlerin matematik öğretimi yaparken başta dil bariyerine takıldıklarını ve buna rağmen matematik öğrenme fırsatları oluşturmaya çalıştıkları görülmüştür. Öğretmenlerin eğitim almadıkları halde mülteci öğrencilerin kültürlerini ve dillerini derse katarak (etnomatematik) dersleri zenginleştirme çabalarına rastlanmıştır. Geçici Barınma Merkezi'nde yaşamanın olumsuz bir dil öğrenme ortamı olduğu ve matematik öğrenimini olumsuz etkilediği belirlenmiştir.

Anahtar kelimeler: matematik öğretimi, matematik öğretmeni, mülteci öğrenci, geçici barınma merkezi

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Research Article

An Innovative Educational Digital Game Design for Primary School Children with Autism

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Abstract –The aim of this study is to reveal the opinions of special education teachers regarding the implementation of an educational digital game developed for primary school children with autism. For this purpose, an educational digital game called "Together with Autism" was developed. The designed game includes numbers, geometric shapes, concepts of size, colours and emotions as taken from the curriculum of the Ministry of National Education for students with autism. The game was applied to 5 students with autism in the presence of a special education teacher, and data on the subject were collected from 5 special education teachers through semi-structured interviews consisting of 9 qualitative questions. The collected data were processed for descriptive analysis after which the findings were interpreted, and conclusions were reached. When the findings were examined, it was found that educational digital games have positive effects on students with autism and the number of such contents should be increased. During the implementation phase of the game, students with autism had fun and reacted to audio and visual stimuli with laughter. Teachers mentioned the lack of digital materials specifically created for this field. In this context, it was concluded that educational digital games should be developed in the field of special education. Teachers stated that educational digital games developed for students with autism increase motivation, support faster and permanent learning, provide learning experiences by having fun, appeal to multiple sensory organs and reduce the burden of the teacher.

Key words: educational digital game, autism, gdevelop, special education, autism and gamification

Introduction

Everyone has different abilities and learning levels. Given these differences, a variety of needs arise as technology advances. These differences are evident in school-age individuals. In this context, the inadequacy and improvement of education and training programmes are on the agenda. Children who cannot develop at the desired level due to individual differences need special education (Çuhadar, 2013). In cases of inadequacies in education and training programmes or due to individual differences, the education of individuals by specially trained people with curricula prepared specifically for this field is called special education (MEB, 2006).

People with special educational needs should be provided special education in order to achieve the same results as their peers, to develop their communication skills and to be integrated into real life. Apart from people who are able to make mental and physical decisions independently and without the need for special support in society, individuals who need support for these needs fall within the framework of special education. Accordingly, individuals whose development is different from normal have special needs (Baykoç Dönmez, 2010). In another definition, the aim of special education is to prepare individuals for independent living (Metin, 2012). It is well known that individuals in society have different physical, mental and social characteristics. Individuals who are physically, mentally and socially less adequate than their peers and who need special education are referred to as "privileged children" (Çağlar, 2019).

Autism is a combination of the Greek word “autos” (self) and the Latin word “ismus” (opinion) (Kuhn & Cahn, 2004). Autism is a spectrum disorder experienced by individuals with social and behavioral inadequacies, indifference to more than one situation, and deficits in understanding and interpretation (APA, 2013). It is crucial that individuals with autism, which is common today (Kurşun, 2022), be prepared for life. In order to integrate these individuals into society, social and psychological pressure factors such as exclusion and labelling must be removed. This is because exclusion is a behaviour that individuals perceive as negative and degrading (Goffman, 1968). Research is needed to prevent these situations, to integrate people with autism into society and to provide targeted benefits in terms of education and training. Although autism spectrum disorder has been included in the low incidence group, the number of individuals with autism is increasing (Eldeniz-Çetin, 2017). According to data from ADDM (Autism and Developmental Disability Monitoring) and CDC

(Centre for Disease Prevention and Intervention), the incidence of autism in individuals is 1/68 (Christensen et al., 2016).

It is indicated that individuals diagnosed with autism have a mental disorder caused by genetic and environmental factors, their social development is not at the desired level, and they have communication and behavioral problems (A Parent's Handbook, 2013; Geller, 2008; Volkmar & Lord, 2007). Considering the mental and social consequences, the main symptoms of autism spectrum disorder are as follows (Aydın, 2019; ASPB, 2016; DSM-IV-TR, 2000):

- Socialization problems
- Language and communication problems
- Reluctance to play mutual games
- Exhibit repetitive behaviours and obsessions
- Having limited interests

People diagnosed with autism have problems communicating with their peers, are reluctant to play and often display similar behaviours. Children with autism who require special education are expected to acquire the necessary skills by remaining in an active position in the field of cognitive development from preschool age. They also need to adapt to the social order of their peers and express themselves. Children with autism who are socialized should be provided with an environment in which they can express themselves well in order to develop their receptive and expressive language.

To improve the cognitive processes of individuals with autism, it is necessary to continue scientific studies and produce evidence-based results (Kurşun, 2022). To this end, computer-based learning activities should be designed and presented in a practical manner to support the mental development of students with autism. Educational digital games to be developed for children with autism should be coded and designed in line with the special education curriculum established by the Ministry of National Education. The digital competencies that should be acquired and considered for children in special education are listed below (MoNE, 2018):

- Cognitive Development Area
- Receptive Language Development Area

- Expressive Language Development Area
- Social-Emotional Development Area
- Adaptive Skills Development Area

Children with autism who require special education are expected to develop the necessary skills by remaining in an active position in the field of cognitive development from preschool onwards. In addition, children need to adapt to the social order of their peers and express themselves. Children with autism who are socialized should be provided with an environment in which they can express themselves well in order to develop their receptive and expressive language. It is possible to provide a conducive environment through educational digital games.

Including educational digital games for children with autism to achieve the benefits offered by the Ministry of National Education can enable them to concentrate by having fun and improve their hand-eye coordination (Bedir Erişti et al., 2017). Therefore, increasing the number of educational digital games, which is one of the computer-assisted pieces of training for children with autism in special education, will be beneficial for special education. It is believed that this study will contribute to the literature.

Purpose and Importance of the Research

This study aims to explore the opinions of special education teachers about the effectiveness of the educational digital game called "Together with Autism" designed by considering the target outcomes for primary school children diagnosed with autism spectrum disorder. It is aimed to eliminate the deficit of educational digital games for special education and to create the digitalization environment mentioned in many studies, to provide rich content based on outcomes for students with autism and to develop their digital competencies. It is aimed to make learning fun for students with autism, to learn by keeping up with technology, to increase their understanding, interpretation capacities and social skills, and to develop and improve their learning experiences. When the literature is reviewed, individuals with autism need rich curricula that activate auditory and multiple sensory organs rather than theoretical and limited curricula (Cohen & Sloan, 2007; Mirenda & Erickson, 2000; Nikopoulos & Keenan, 2006; Prizant et al., 2006).

Kurşun (2019), who wanted to reveal the impact of games on children with autism, organised developmental play therapy sessions for children with autism in a study. The results

revealed that there was an increase in the social relationships of children with autism. Josefi and Ryan (2004), in a case study for children with autism, applied play therapy sessions to 6-year-old children with autism. As a result of the study, it was found that there were improvements in children's sense of autonomy and role-playing skills. Considering the results of the studies, it is understood that the educational digital activities to be developed for children with autism will spark their interest.

İnce et al. (2023) examined the master and doctoral theses on children with autism published between 2008 and 2023 employing content analysis. They reached the conclusion that studies on the play skills of children with autism in the last 15 years were insufficient. At the same time, it was emphasized that it would be useful to include experimental studies. In addition to experimental studies, it was stated that observation, interview and descriptive studies would be valuable in terms of addressing the gap in the literature. It is thought that the research will contribute to the literature and pave the way for digital materials to be developed for special education and educational digital games to be integrated into the curriculum. In this context, the questions sought to be answered within the scope of the research are as follows;

1. What difficulties do the teachers experience in the education/teaching of children with autism?

2. What kind of study materials should be used in the education of children with autism according to the teachers?

3. Should technology be used in the education of students with autism according to teachers?

4. What are the views of teachers on the use of technological devices such as phones, tablets and computers in the education of students with autism?

5. Do educational materials prepared in digital environment support the learning process of students with autism according to teachers?

6. What do the teachers think about the educational digital game (together for autism) developed for children with autism?

Method

This section describes the research design used to arrive at the research findings, the study group, the data collection instruments, the analysis of the data collected and the stages of implementation of the research.

Research Design

The aim of this study is to reveal the opinions of special education teachers about the application after the implementation of the educational digital game developed for primary school children with autism and containing the achievements. This study was conducted using a case study, which is one of the designs of qualitative research methods. Qualitative research is a research method in which qualitative data collection methods such as observation, interview or document analysis are used and perceptions are revealed (Yıldırım & Şimşek, 2008). Case study is a qualitative approach in which the researcher analyses a limited situation using data collection tools such as observation and interview (Creswell, 2007).

Study Group

This research is aimed at students with autism spectrum disorder at the primary school. Since it would not be appropriate to collect data scientifically from the students with autism in the study, the study group of the research consists of 5 primary school special education teachers in a special education practice school in Sancaktepe district of Istanbul province. Demographic information about the 5 special education teachers from whom data were collected is given in Table 1 below.

Table 1 Demographic Information of the Participants

Gender	Age	Education Status
Female	24-30	Bachelor's degree
Male	24-30	Bachelor's degree
Female	30+	Bachelor's degree
Female	30+	Bachelor's degree
Female	24-30	Bachelor's degree

As shown in Table 1 4 of the teachers in the study group are female (80%) and 1 (20%) is male. Three of the participants (60%) were between the ages of 24-30 and two (40%) were between the ages of 30+. All participants have a bachelor's degree.

Data Collection Tools

In this study, Google Form tool, which consists of 9 questions, 3 of which are demographic and 6 of which are open-ended, was used as a data collection tool. This Google form also includes a semi-structured interview form.

Data Collection Process

Under this heading, the implementation details and data collection process of the educational digital game named "Together with Autism", which was designed by taking into account the curriculum prepared by the Ministry of National Education for students with autism, are given.

"Together with Autism" designed for primary school children with autism Details of Implementation

In this study, "Together with Autism" application was designed in order to reveal the effectiveness of educational digital games used in the field of special education and to include the opinions of special education teachers about educational digital games. The outcomes of the application within the scope of the curriculum for students with autism and the details about these outcomes are given in Table 2 below.

Tablo 2 Gains of the Together with Autism Practice

No	Achievement	Details of Achievement	Usage within the Application
1	Matching Objects by Their Colours	He/she recognizes and categorizes the given colours and shapes.	A total of 3 scenes related to colour recognition and matching are included. In Scene 1, the child with autism identifies the colour mentioned to them on the computer screen and selects the colour using the directional arrows on the keyboard (Appendix 1-a)
2	Counting rhythmically and recognizing numbers	He/she verbally identifies and rhythmically counts the numbers encountered in daily life	A total of 3 scenes related to recognizing and matching the numbers encountered in daily life on the computer screen are included. The child with autism verbalizes the number that appears on the screen and selects the correct number using the directional arrows on the keyboard (Appendix 1-b)
3	Recognizing rectangle, square, circle, and triangle	He/she recognizes geometric shapes and names them	A total of 3 scenes covering basic geometric shapes such as rectangle, square, circle, and triangle are included. The child with autism, after finding the requested shape, drags it with the mouse and places it inside the relevant box (Appendix 1-c)
4	Recognizing facial expressions depicting joy, anger, sadness, and crying emotions	He/she recognizes facial expressions for basic emotions	A total of 3 scenes aimed at recognizing facial expressions representing joy, anger, and crying are included. The child with autism clicks on the specified facial emojis (Appendix 1-d)

5	Differentiating objects by size	He/she identifies which of the specified shapes is larger and which one is smaller.	A total of 2 scenes related to the size of objects are included. The child with autism moves the character on the computer screen to the desired geometric shape using the keys on the keyboard (Appendix 1-e)

Table 2 shows the learning outcomes in the MoNE curriculum for students with autism. Looking at the objectives, we can see that students with autism are expected to be able to identify colours and represent them on the computer screen using the keyboard, to represent and highlight the numbers they encounter in everyday life on the computer screen, to understand the concepts of large and small, to identify commonly used geometric shapes and match them on the computer, to know the meanings of commonly used facial expressions and match them on the computer screen. Students with autism spectrum disorder are easily distracted. Their problem solving, comprehension, analysis and synthesis skills are at a lower level compared to their peers. Based on this situation, clear, understandable expressions, appropriate visuals, colours and sound stimuli have been included in the prepared digital game. In this way, the aim is to prevent the student with autism from getting bored with the digital game.

Advantages of the GDevelop Programme and Its Use in Special Education

GDevelop is a flexible game engine used to develop 2D games. With this programme, applications can be developed for web, desktop, Android and IOS environments. In addition, the programme can run on Windows, Linux and macOS. In this study, all contents of the educational digital game, titled “Together with Autism”, was developed and published for students with autism using GDevelop programme. GDevelop allows text-based coding as well as block-based coding. Therefore, it offers an ideal environment for developing and publishing applications. GDevelop provides a rich learning environment for the target audience as it facilitates the implementation of pedagogical elements such as easy to difficult, concretization, reinforcement, feedback, reminder, repetition, hint, rewarding and the others in accordance with the teaching principles used in the field of special education. At the same time, with this programme, different and integrated visual and auditory materials can be developed for students with autism.

Implementation of the Developed Educational Digital Game with Autism

The educational digital game “Together with Autism”, which was prepared for students with autism, was carried out with the participation of 5 students with autism who know how

to use a computer or can use it with guidance in a special education application school in Sancaktepe district of Istanbul province after having received the necessary permissions. The implementation phase of the research lasted a total of 5 lesson hours with 1 hour per student. At this stage, each teacher observed the reactions of the students with autism to the game on the computer and provided assistance to those having difficulty. Many students showed feelings of happiness towards the audio and visual stimuli in the educational digital game and reacted to reinforcers such as applause by laughing and rejoicing.

Data Collection

Within the scope of the research, after the implementation of the educational digital game named "Together with Autism", which was designed uniquely within the scope of the research and includes target acquisitions, to 5 students with autism, the data were collected face-to-face from 5 special education teachers via Google Form, which includes a semi-structured interview form, for it would not be appropriate to collect data from students with autism. After each implementation, special education teachers responded to the research questions. At this stage, 5 special education teachers were asked to evaluate the "Together with Autism" application and to indicate the effects of similar applications on the education of students with autism.

Data Analysis

In light of the qualitative data collected from special education teachers, the descriptive analysis was used to reveal the level of impact of the educational digital game developed for students with autism on students with autism and the teachers' views on the role of educational digital games in special education. The descriptive analysis is a method that is used to obtain summary information about the research on the basis of the collected data (Büyüköztürk et al., 2008). The answers given by the teachers to the open-ended questions were analysed, compared with the literature and classified according to the themes that were determined in advance. At this stage, the answers provided by the special education teachers to the research questions were not shared with third parties in order to protect personal data, and the teachers were given symbolic participant numbers (e.g., P1, P2.).

Data collected from the teachers using the interview form were presented to 2 experts. The experts examined and analyzed the codes extracted from the teachers' opinions. The method of Miles and Huberman (1994) was used to ensure the reliability of the extracted codes. The aim of this method was to increase the reliability of the study by means of inter-

observer agreement. Independent interobserver agreement method is used to ensure that results obtained by different experts using the same measurement tool to assess the same situation are compatible (Esin, 2014). The codes revealed by the Miles and Huberman method are included in the analysis of qualitative data based on formatting (Maxwell, 1992; Roberts & Priest, 2006; Öztürk & Balcı, 2014). The codes were calculated in the form of "reliability = agreement / (agreement + disagreement)". The reliability of the study was found to be 95%. The experts emphasized that the study was reliable.

The scheme summarising the methodology of the research is shown in Figure 1 below:

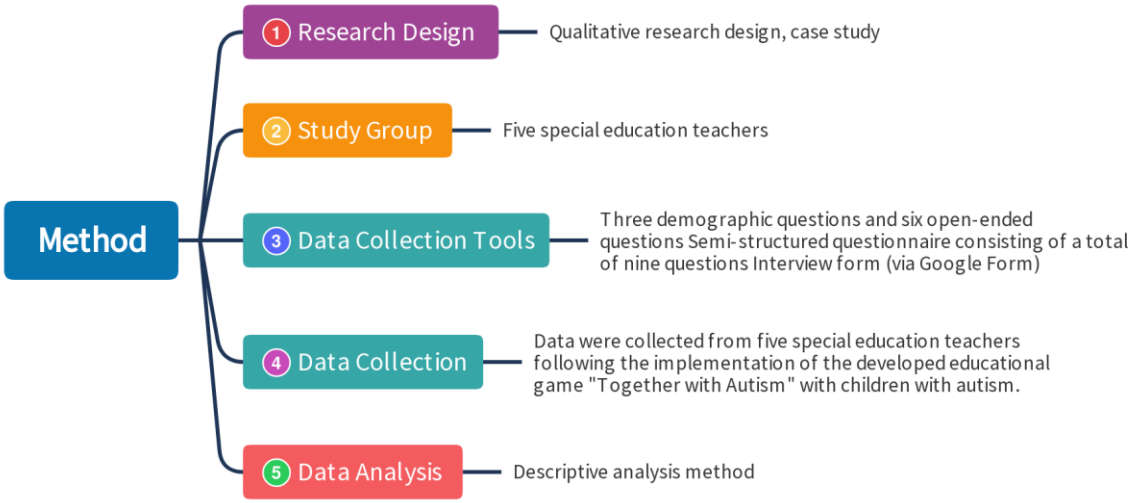

Figure 1 Summary Scheme of the Research Method

Results

Under this heading, after the implementation phase of the research was carried out, the opinions of special education teachers on educational digital games and "Together with Autism" application were included. The qualitative questions of the research were analysed under the relevant headings and the findings were reached by correlating them with the literature.

Findings related to the question of what difficulties the teachers experience in the education/teaching of children with autism

This question aims to unearth the problems encountered by special education teachers while helping students with autism achieve the learning outcomes. Teachers' responses to this question are shown in Table 3 below.

Table 3 Problems Encountered in the Education of Children with Autism

Theme	Codes	Participants	Frequency	%
Difficulties in the education/training of students with autism	Lack of academic digital materials	P1, P2, P3	3	60
	Behavioural problems	P1, P4, P5	3	60
	Lack of audio and visual materials	P3, P4	2	60
	Lack of smart board and educational videos	P2, P4	2	40

When the details of Table 3 are examined, it is seen that among the problems frequently encountered by special education teachers, the frequency of lack of academic digital materials and behavioural problems is 3 (60%), and the frequency of lack of audio-visual materials, smart board and educational videos is 2 (20%). Participant views on this question are as follows;

P1: "We have problems due to lack of digital materials and behavioural problems"

P3: "We have problems due to the lack of visual and audio materials"

P4: "We lack a smart board. We can progress faster with educational videos"

When the opinions of participants numbered one, three and four are examined, educational digital games, visual and audio-visual materials are the main deficiencies in the teaching of students with autism. In addition, behavioural problems are also seen as difficulties. Participants also mentioned the lack of smart boards. It is concluded that the lack of smart boards will create difficulties in the implementation of digital activities. Teachers mentioned the lack of academic digital materials in the field of special education.

Findings related to the question of what kind of study materials should be used in the education of children with autism according to the teachers

This question reveals what materials can be useful for students with autism in the classroom. The educational materials suggested to be used by teachers in order to direct students with autism to the lesson, increase their motivation and enable them to learn by having fun are shown in Table 4 below.

Table 4 Recommended Materials in the Education of Children with Autism

Theme	Codes	Participants	Frequency	%
Materials to be used in the education of students with autism	Digital materials	P2, P3, P4	3	60
	Concrete shapes	P1, P5	2	40
	Audio and visual materials	P3, P4	2	40
	Educational materials that appeal to more than one sense organ	P3, P4	2	40
	Materials supporting motor development	P4	1	20
	Puppet and concept sets	P5	1	20

When the details of Table 4 are looked into, it is seen that the materials recommended by special education teachers to be used in teaching students with autism. Considering the number of participants in the answers, it is seen that the frequency of digital materials is 3 (60%), the frequency of concrete shapes, visual, auditory and materials that appeal to more than one sense organ is 2 (40%), the frequency of materials supporting motor development and puppet-concept sets is 1 (20%). The answers given by the teachers are as follows;

P1: "Concrete shapes and colours can be used."

P2: "Digital activities and independent interesting materials can be used to appeal to more than one sense."

P3: "Colourful and digital materials."

P4: "Visual materials, smart board and materials to support motor development can be included."

P5: "Puppets and concept sets can be used for language development."

Participant 1 stated that concrete shapes and colours can be used in the education of children with autism. Another participant, teacher number two, suggested that materials that appeal to more than one sense organ can be used and pointed out that digital activities and interesting learning materials can be used in the education of children with autism. Participant 3 said that digital and colourful materials could be used as effective learning tools in support of participants 1 and 2. Participant 4 emphasized that smart boards and visual materials would be effective by highlighting the development of motor skills of students with autism. This view was interpreted as the development of hand-eye coordination in order for students with autism to acquire, use and infer information in the digital environment. Participant 5 stated that puppets and concept sets could be included by prioritizing the language development of

children with autism. When the responses of the teachers are considered holistically, it is seen that it would be useful to organise the existing learning environments of students with autism in a way to support technology. It is stated that rich learning environments will be created by using educational materials that arouse the interest and attention of students with autism, support their motor development, contain visual and auditory elements, and prioritise language development. In this case, it can be said that the use of digital materials such as computers and smart boards will increase the digital competences of children with autism.

Findings related to the question of that technology should be used in the education of students with autism according to teachers

This question seeks to answer whether technology can be used in addition to traditional teaching methods in the education and training of students diagnosed with autism. In this context, it was revealed to what extent and for what purpose and when technology is used in special education and what its effect is on students with autism. The responses of the teachers to this question about the use of technology in special education are shown in Table 5 below.

Table 5 Findings Related to the Use of Technology in the Education of Students with Autism

Theme	Codes	Participants	Frequency	%
The use of technology in the education of students with autism	Can be used according to the student's performance	P1	1	20
	Appeals to more than one sense organ, can be used	P2	1	20
	Makes teaching permanent, can be used	P4	1	20
	Increases attention span, can be used	P5	1	20

When Table 5 is analysed, findings related to the use of technology by students with autism in the field of special education are seen. It is understood that the use of technology can be evaluated according to student performance, appealing to more than one sense organ, making teaching permanent and increasing attention span. The answers given by the teachers are as follows:

P1: "Yes, it should be used according to the performance of the student."

P2: "Yes, technology should be used because it appeals to more than one sense organ."

P3: "Technology should be used for permanent teaching."

P5: "Yes, I think it increases attention span in children with autism."

In the answers given about the use of technology in the field in question, it was emphasised that it can be used based on the performance of the student. From this response, it is understood that technology can be utilised aligned with the learning levels of students with autism who show individual differences in terms of learning. In this way, it is thought that the learning environment will be organised in light of individual differences and the digital skills of students with autism will be increased. Participant 2 emphasised that technology appeals to more than one sense organ and can be used in the education of students with autism. Participant 3 emphasised that technology should be used in order for the target outcomes to be permanent in students with autism. In this case, the use of technology can be interpreted as students with autism can progress at individual learning speed and internalise knowledge. It was also stated that technology can provide the opportunity to include elements that can capture the attention of students with autism.

Findings related to the question of what the views of teachers on the use of technological devices such are as phones, tablets and computers in the education of students with autism

This question explores the effect of technological devices such as phones, tablets and computers used in the education and training of autism students. Teachers evaluated the role of technology in the cognitive, affective and kinaesthetic skills of students in special education by considering the developing technology. Table 6 below shows the responses given.

Tablo 6 Opinions on the Use of Phones, Tablets and Computers in the Education of Students with Autism

Theme	Codes	Participants	Frequency	%
The use of technological devices in the education of students with autism	Can be used purposefully	P2	1	20
	Can provide fun and permanent learning	P3	1	20
	Increases attention span	P5	1	20

As demonstrated in Table 6, in the answers given by the teachers regarding the use of technology in teaching students with autism in special education, it is mentioned that the use of phones, tablets and computers can increase the attention span of students, make learning fun and permanent, and can be used purposefully. The answers given are as follows;

P2: "Educational digital games can be used for the purpose accompanied by teachers."

P3: "I find it right because learning can be more fun and permanent."

P5: "It increases attention span."

Teachers emphasised that educational digital games can be used in technological devices. Therefore, it is found that mobile and desktop applications to be created for the achievements of students with autism can be integrated with in-class and extracurricular activities. They also stated that a well-designed educational game content increases the attention span of students. In the implementation phase of the "Together with Autism" game developed in this study, it was observed that students with autism learnt while having fun. This situation supports the teachers' view that phones, tablets and computers "can provide fun and permanent learning". In addition, with the learning diversity provided by technological devices, audio and visual stimuli are used. Sula and Spaho (2014) stated in their study that individuals with autism who use technological devices access information more easily and provide individual learning. Therefore, it is understood that the amount of digital content should be increased in children with autism, and it may be appropriate to use digital content that stimulates visual, auditory and multiple sensory organs.

Findings related to the question of that educational materials prepared in digital environment support the learning process of students with autism according to teachers,

This question reveals how the learning processes of students with autism are affected as a result of the integration of the gains they have achieved within the scope of the curriculum into the digital environment. The answers given by the teachers include educational digital games designed and coded for students with autism and other teaching tools and materials in the digital environment. The positive and negative responses of the teachers regarding the effect of digital education materials on the educational process are given in Table 7 below.

Table 7 Opinions on the Effect of Educational Materials Prepared in Digital Environment on the Learning Process of Students with Autism

Theme	Codes	Participants	Impact	Frequency	%
The effect of materials prepared in digital environment on the learning of students with autism	Offers a fun environment	P2, P3, P4	Support	3	60
	Provides fast learning	P4	Support	1	20
	Improves visual memory	P4	Support	1	20
	Makes it easier to attract attention	P5	Support	1	20

This question reveals how the learning processes of students with autism are affected as a result of the integration of the gains they have achieved within the scope of the curriculum into the digital environment. The answers given by the teachers include educational digital games designed and coded for students with autism and other teaching tools and materials in the digital environment. The positive and negative responses of the teachers regarding the effect of digital education materials on the educational process are exhibited in Table 7 below.

P2: "...prevents children from getting bored by creating a fun environment."

P3: "can shorten the learning process."

P4: "Yes, they do. Their visual memory is stronger, and it is fun."

P5: "It affects attention span positively. Digital media is an attention-grabbing stimulus, it supports students by increasing their attention span."

From the participant opinion number two, it is concluded that digital materials support students with autism to learn by having fun. It can be said that educational digital contents increase classroom control and prevent students from getting bored. Therefore, educational digital contents can be included in special education for children with autism to have a pleasant time, to provide permanent learning at cognitive level and to increase their digital skills. Participant 3 stated that educational digital activities can shorten the learning process. Participant 4 stated that the visual memory of students with autism can improve as a result of the use of digital materials. In addition, participant 5 stated that such materials and activities would increase attention span and act as an attractive stimulus. Considering the responses of the teachers, it can be concluded that educational materials prepared in digital environment can positively affect the learning experiences of students with autism.

Findings related to the question of what the teachers think about the educational digital game (together for autism) developed for children with autism

This question reveals the effect of the educational digital game, which was originally developed for students with autism and includes colours, numbers, size and smallness concepts, geometric shapes and emotions, on students with autism. In this context, teachers' opinions were analysed and shown in Table 8 below.

Table 8 Teachers' Opinions on the Effectiveness of Together with Autism Practice

Theme	Codes	Participants	Frequency	%
Opinions on the "Together with Autism" application developed for students with autism	Offers a fun environment	P2, P3	2	40
	Reduces the burden on teachers	P3	1	20
	Increases awareness	P4	1	20
	Supports cognitive and affective processes	P5	1	20

When Table 8 is analysed, it is seen that the frequency of participants stating that the educational digital game in question offers an entertaining environment is two (40%), and the frequency of participants stating that it reduces the burden of teachers, increases awareness and supports cognitive-affective processes is one (20%). The opinions of the teachers are as follows:

P1: "I think educational digital games are useful, they should be developed."

P2: "By considering the principle of individual differences, the learning process can emerge, a fun environment is created."

P3: "Educational digital games make learning more fun and support learning in a shorter time. Having them in schools facilitates teachers' teaching."

P4: "It is a good project in terms of education, it is a good study in terms of awareness."

P5: "*There should be digital games in special education. I think that they support students developmentally (visual, hearing, mental). Using them as an attention-grabbing material for students and using them as reinforcers in the treatment of problem behaviour has positive effects.*"

Participant 1 stated that such educational digital games have a positive effect on students with autism and they are beneficial. After the implementation phase of the educational digital game developed originally, students with autism had fun, and after answering the questions, they reacted loudly with joy and laughter. In addition, in the opinion of participant 2, individual differences and learning by having fun come to the fore. It is thought that educational digital games to be developed in different difficulties especially for students with autism at different levels can make important contributions to individual progress. In the opinion of participant 3, such applications can be fun and reduce the burden

on teachers and support rapid learning. Considering the obligation of teachers to prepare materials in special education, it can be said that digitalisation can provide both diversity and time saving. Participant 4 stated that the "Together with Autism" application could be a pioneer in increasing the number of applications developed for special education. From the opinion of participant number five, it is found that the mental processes of students with autism can be supported by educational games. It was said that digital activities can be used in the treatment of students with behavioural disorders. In addition, it is understood that digital games will be useful in subjects where learning in certain subjects should be reinforced.

Conclusion, Discussion and Suggestions

This research can be considered as a contribution to enrich curricula for students with autism, to make them compatible with technology, to make learning fun and to make educational digital games widespread. When the findings of the research are examined, it is seen that the teachers working in special education field are warm to digitalisation, support the use of technological tools in the education and training of students with autism and stated that the variety of digital materials should be increased. As a matter of fact, during the implementation phase of the research, it was observed that students with autism were very interested in digital materials. They followed the instructions given to them carefully. In this process, teachers stated that students with autism enjoyed digital games and enjoyed working in a computer environment. This situation makes it possible to use technological devices such as phones, tablets and computers to achieve the target outcomes. On the other hand, seeing the concepts that students with autism have difficulty in understanding and internalising in the digital environment as moving, colourful and audible grabs their interest and attention. This finding shows that digitalisation and blending of curricula prepared for students with autism with technology would be beneficial.

As stated by the teachers in this study, educational digital games are a source of entertainment for students with autism. During the implementation phase, it was observed that students with autism touching the keys on the keyboard and reaching the desired result by moving the object on the screen is a rich learning environment for them. Educational digital games also reduce the burden on teachers in the classroom. Students can follow the achievements in the digital environment at their own individual pace. Therefore, individual differences are taken into consideration. Special education teachers were also satisfied with this situation and stated that the potential of the children was revealed because educational

games enable students with autism to socialise and develop their receptive and expressive language. It improves visual perception and increases interest. In line with this finding, Şenyürek et al. (2017) emphasised that more educational digital games should be developed to increase the participation of students with autism in the lesson and to ensure effective implementation of the instruction, as games enable individuals to discover themselves (Ünal, 2009) and increase their motivation.

Quill (1997) stated that using visual and auditory perceptions together will provide better learning in students with autism. It is known that games are used to correct behavioural disorders in students with autism. For behavioural disorders, which is one of the problems stated by teachers, Carrizales (2015) stated that as a result of the play therapy study on children, behavioural disorders decreased, and they started to behave normally. Therefore, it can be said that educational digital games to be created within the scope of the curriculum in digital media will have a positive contribution to the behaviour of students with autism. In the opinions of teachers regarding the use of technology in special education, it was found that educational digital games make teaching permanent, appeal to more than one sensory organ and increase attention span. It was also stated that there would be improvement in the motor skills of students with autism. In order to use technological tools, it is necessary to be technologically literate at a certain level. It can be said that the fact that students with autism are familiar with digital environments from an early age will help them develop their technology literacy skills in the future. Teachers stated that they needed academic digital materials in order to implement educational games. They said that smart boards are the most important of these. In this case, it is understood that the technological infrastructure in schools where special education is delivered should be improved in order to implement educational digital games developed for children with autism.

In a study by Bedir Erişti et al. (2017), they emphasized that educational digital games should be developed by taking into account the cognitive, affective and psychomotor characteristics of students with autism. They also stated that positive results will be obtained as a result of good and planned design of educational digital games for students with autism whose communication skills are weak and whose social development is not at the desired level. They stated that computer-assisted applications may be useful for students with autism. In addition, it is known that games will help children with autism improve their hand and eye coordination as well as improve their behaviour (Tsai and Lin, 2011; Faja et al., 2008). Therefore, it can be said that the educational digital game called "Together with Autism",

developed for students with autism can increase social relations and activate affective and cognitive processes.

Within the scope of this study, it was found that the educational digital game "Together with Autism" experienced by 5 students with autism was effective and the students saw the game as a tool, motivation enhancer and entertainment to achieve the outcomes. Considering the limitations of the study, it can be suggested that similar studies should be designed and implemented on more students with autism in a way that include different achievements. In addition, it may be possible to develop and disseminate innovative practices for the curriculum. It can be considered to provide smart board integration in special education autism classes and to create a learning environment that will appeal to multiple sensory organs of students with autism by switching to digitalisation. As stated by İnce et al. (2023), considering the limitation of studies on children with autism, it could be possible for different universities and researchers to contribute to the literature by using different methods.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

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CRediT author statement

The study was conducted and reported with equal collaboration of the researchers.

Research involving Human Participants and/or Animals

Ethics Committee Approval (Date: 29/09/2023, Number: 5) for this research was obtained from the Human Research Committee on Ethics at Bursa Uludağ University.

İlköğretim Otizmli Çocuklar İçin İnovatif Eğitsel Dijital Oyun Tasarımı

Özet:

Bu çalışmanın amacı, ilköğretim otizm spektrum bozukluğu bulunan öğrencilere yönelik özel eğitim öğretim programında bulunan kazanımları eğitsel dijital oyunlar vasıtasıyla öğretmektir. Bu amaca yönelik "Otizm ile Birlikte" adlı eğitsel dijital oyun geliştirilmiştir. Tasarlanan oyunda, Milli Eğitim Bakanlığı'nın otizmli öğrencilere yönelik öğretim programından alınan sayılar, geometrik şekiller, büyüklük küçüklük kavramları, renkler ve duygular yer almaktadır. Tasarlanan eğitsel dijital oyun 5 otizmli öğrenciye özel eğitim öğretmeni eşliğinde uygulanmış ve konuya ilişkin veriler 5 özel eğitim öğretmeninden 9 nitel sorudan oluşan yarı yapılandırılmış görüşme formu ile toplanmıştır. Toplanan veriler betimsel analizine tabi tutulmuş ve bulgular yorumlanarak sonuçlara ulaşılmıştır. Bulgulara bakıldığında, eğitsel dijital oyunların otizmli öğrenciler üzerinde olumlu etkilerinin olduğu, bu tür içeriklerin sayısının artırılması gerektiği vurgulanmıştır. Eğitsel yazılımın uygulama aşamasında otizmli öğrenciler eğlenmiş, sesli ve görsel uyaranlara gülerek tepki vermişlerdir. Öğretmenler, bu alana yönelik akademik olarak oluşturulan dijital materyallerin eksikliğinden söz etmişlerdir. Bu bağlamda, özel eğitim alanında kazanımlara yönelik oluşturulacak eğitsel dijital oyunlara yer verilmesi gerektiği sonucuna ulaşılmıştır. Öğretmenler, otizmli öğrencilere yönelik geliştirilen eğitsel dijital oyunların motivasyonu artırdığını, daha hızlı ve kalıcı öğrenmeleri desteklediğini, eğlenerek öğrenmeyi sağladığını, birden fazla duyu organını harekete geçirdiğini ve öğretmenin yükünü azalttığını belirtmişlerdir.

Anahtar kelimeler: eğitsel dijital oyun, otizm, gdevelop, özel eğitim, otizm ve oyunlaştırma

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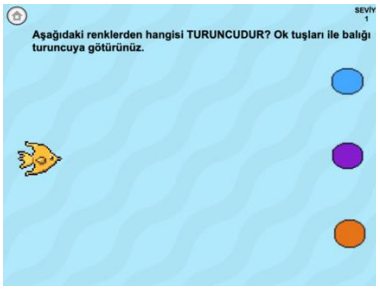
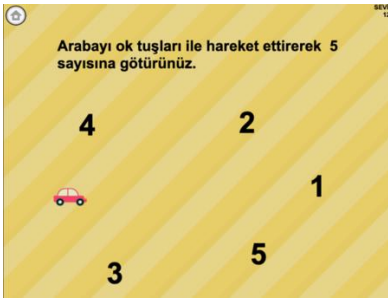
Appendices

Appendix 1-a



Appendix 1-b



Appendix 1-c

Appendix 1-d

Appendix 1-e

Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi
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Research Article

Middle School Students' Math Experiences and Creative Skills with Op Art

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Abstract – The present research aimed to explore the perspectives and creations of middle school students regarding Op Art design activities. Four Op Art activities were implemented in this study. The students' opinions were collected through an observation form, an open-ended questionnaire, and individual interviews. Content analysis was employed to analyze the students' responses. The students' Op Art designs were evaluated using a creativity diamond model comprising frequency, flexibility, originality, and elaboration competencies. Three themes emerged from the students' Op Art design process: mathematical expression, visual expression, and creativity skills. Similarly, six themes were identified from the students' viewpoints on Op Art designs: general perspectives on Op Art designs, aspects of Op Art design activities that were liked or disliked, the success of the created designs, exciting aspects of the Op Art activity, perspectives on the use of Op Art activities in mathematics lessons, and instructive aspects of Op Art activities. This study suggests that Op Art activities have the potential to enhance students' creativity, particularly flexibility competencies, and foster an appreciation for the process rather than solely focusing on the end result.

Key words: creativity, experience, geometry, middle school students, Op Art.

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Introduction

Geometry is a branch of mathematics consisting of mathematical shapes and formulas. However, geometry is also heavily associated with art. Geometry and art can always be considered together as inherently intertwined (Heskett, 2007). Since geometry is rich in shapes, lessons emphasizing the relationship between geometry and art can be created (Perignat & Katz-Buonincontrö, 2019; Starko, 2013). Recent studies have shown that the inclusion of art, especially in geometry courses, increases the interest and curiosity of students in learning mathematics (Hesket, 2007; Perignat & Katz-Buonincontrö, 2019). Different kinds of art, such as visual art, origami, fractal, and storytelling, can be used in a wide range of school levels, from kindergarten to high school education, to teach mathematical concepts (Brewer, 1999; Hesket, 2007; Mercat et al., 2017).

Optical Art, Op Art, is a visual art that uses geometric shapes, lines, and colors to create an eye illusion, movement, depth, or vibration (Parola, 1996). Op Art is also abstract art and creates optical illusions in the eyes of the viewer (Parola, 1996; Zanker & Walker, 2004). With the invention and development of movies, television, and the internet in the 20th century, the concept of motion in the visual arts was discussed, and thus kinetic art emerged (Riley, 1999). Kinetic art formed the basis of Op Art, and thus Bridget Riley, one of the first Op Art artists, created illusions that give a sense of movement to still pictures with black and white drawings (Riley, 1999; Solso, 1994). In addition, Op Art attracted attention by integrating concepts such as depth and movement into two-dimensional paintings. Thus, with Op Art, illusions, that is, pictures that evoke a sense of movement, have attracted the attention of psychologists, artists, and many people from different fields (Parola, 1996; Solso, 1994). Today, Op Art activities have been used in mathematics lessons to show the integration of geometry and art, and arouse students' interest (Brewer, 1999; Heskett, 2007; Mercat et al., 2017).

Op Art is often associated with creativity due to its manipulation of visual perception, exploration of form and space, and interactivity (Mercat et al., 2017). Although there are many definitions of the word creativity, the most frequently used concepts in these definitions are genuine, original, and unique (Perkins, 1988; Starko, 2013). For example, Perkins (1988) stated that an innovative product should be original and unique. Creativity is an essential skill for people to produce original ideas. Although creativity was a skill that was considered essential to produce new products or maintaining intense competition in workplaces and companies, today, it is expected that students experience and develop this skill from the first

years of education (MEB, 2018). Creativity is also an essential skill that students need to develop in STEAM (Science, Technology, Engineering, Art, and Mathematics) education (Akgündüz et al., 2015; Daugherty, 2013).

Upon reviewing the extant literature pertaining to Op Art, it becomes evident that Op Art has predominantly served as an instructional instrument for imparting various geometric concepts to students within the educational context. To illustrate, the study by Brewer in 1999 explored the use of Op Art visuals as an educational tool for primary school students. The aim was to enhance their understanding of straight lines like vertical, horizontal, perpendicular, parallel, and intersecting lines, as well as the general properties of geometric shapes like rectangles, squares, and ovals. Heskett's work in 2007 showed that Op Art offers students an opportunity to explore geometric concepts in visual art by examining various Op Art works. Some Op Art pieces allowed students to explore symmetry, depth perception, and basic geometry definitions like perspective and similarity. The study also highlighted the potential for students of all grade levels to practice creativity skills in mathematics, emphasizing the relationship between mathematics and creativity in problem-solving and idea development. Thus, Op Art was seen as a valuable tool for promoting creativity in education, as it involves a creative process in addition to the final artistic product.

The studies above show that Op Art can be used as a STEAM activity to improve creativity. However, in the literature on the subject, no research examines the views and experiences of middle school students on the creation process of Op Art. Therefore, examining the views and experiences of middle school students on the Op Art design process is significant. It contributes to the ideas that can be used to develop creativity in mathematics classes. In line with the above reasons, this study examines how middle school students experience their creativity skills while reproducing shapes designed by famous Op Art artists and relating the mathematical concepts in these designs.

The research questions of this study are stated below.

1. How is the process of Op Art design for middle school students?

2. What are the opinions of middle school students toward designing Op Art?

Op Art, Creativity, and STEAM

In his study, Brewer (1999) prepared Op Art visuals with primary school students to better learn the names of straight lines, such as vertical, horizontal, perpendicular, parallel,

and intersecting lines. In addition, Brewer showed that with Op Art activities, students better learned the general properties of geometric shapes such as rectangles, squares, and ovals. Heskett (2007), on the other hand, showed that Op Art provides an opportunity for students to see how geometric shapes are used in visual art, and by examining different Op Art works, students find opportunities to explore various geometric concepts. For example, with Op Art named Blue/Red created by Victor Vasarely in Figure 1, students; (a) examine the concept of symmetry, (b) discover that depth can be created by changing some properties of circles given on a two-dimensional surface, and (c) learn some basic definitions such as perspective, symmetry, similarity used in geometry.

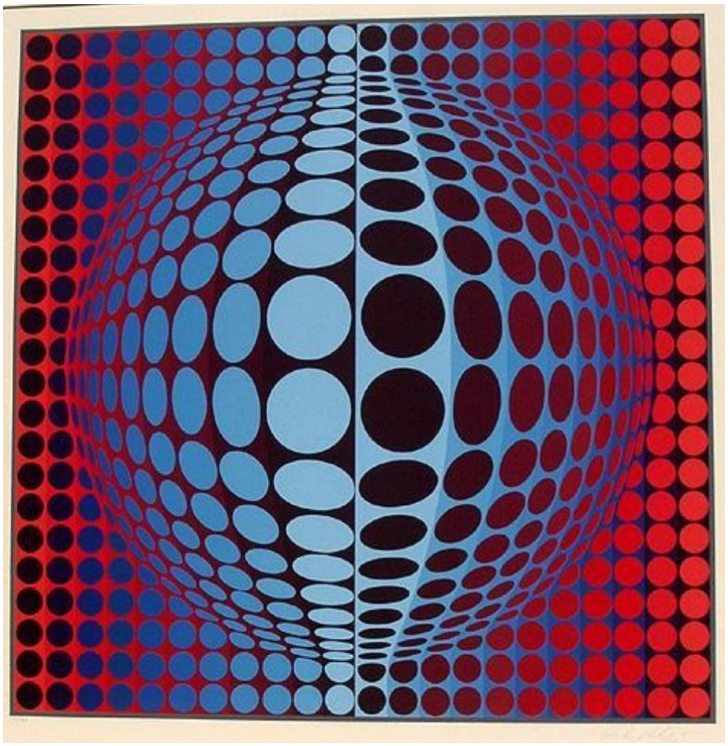


Figure 1 Op Art Blue/Red by Victor Vasarely (Heskett, 2007)

Art activities such as Op Art could have a positive effect on students' success, as they could both attract attention and encourage the use of skills such as creativity (Brewer, 1999; Heskett, 2007; Starko, 2013). Since creating Op Art designs requires a certain process and not only the resultant design (product) but also the process itself is important, it makes an important contribution to creativity (Vygotsky, 2004). Op Art designs can be implemented in a STEAM activity, as it brings together the disciplines of mathematics and art and includes skills that are considered among 21st-century skills, such as creativity (MEB, 2018; Perignat & Katz-Buonincontrö, 2019).

STEM education is an educational model in which the disciplines of Science, Technology, Engineering, and Mathematics interact. STEM education aims to provide students with the ability to think interdisciplinary and thus raise generations whose 21st-century skills such as creativity, problem-solving, critical thinking, and collaboration are developed (Akgündüz et al., 2015; United States Department of Education, 2022). Since STEM education mostly aims to develop student's creativity, innovation (invention), and problem-solving skills by adding art discipline to STEM education (Çepni, 2018; Liao, 2016; Morari; 2023; Perignat & Katz-Buonincontrö, 2019), creativity and invention skills were emphasized more (Daugherty, 2013).

As noted by Henkriksen (2014), incorporating art into the STEM approach has several positive effects on students. It reduces anxiety related to the lesson, boosts motivation and fosters positive attitudes, even though it may be challenging and time-consuming in classrooms. The inclusion of art in the interdisciplinary approach also leads to increased classroom participation (Perignat & Katz-Buonincontrö, 2019). Moreover, it allows students to recognize the connections between Science, Mathematics, Technology, Engineering, and Art. Incorporating the art field into the STEM concept has led to its expansion and widespread adoption as STEAM, as evidenced by studies such as those by Razi and Zhou (2022) and Wu et al. (2021). In STEAM applications, students' motivation for the lesson is enhanced when they create products through small-scale designs. Producing a tangible product at the end of these activities reinforces the practicality of their existing knowledge and encourages them to pursue further learning (Morari, 2023; Ozkan, 2022).

Perignat and Katz-Buonincontrö (2019) reviewed 44 articles in a literature review on STEAM education. They stated that in half of the studies, the aim of STEAM education was defined as the development of creativity skills in students. Mathematics is one of the disciplines directly associated with creativity (Leikin, 2009). It is possible for students from all grades to practice creativity skills (Leikin & Siriraman, 2017). Some examples of the relationship between mathematics and creativity are; determining the shapes and the relations between them, approaching them from different perspectives, problem-solving, and developing different ideas (Starko, 2013, p. 228). Liu and colleagues (2023) indicate that mathematics plays a relatively insignificant role within STEAM learning since mathematics serves as a foundational element across various disciplines. Thus, without a solid grasp of mathematics, a comprehensive understanding of other fields becomes challenging to attain.

Op Art can be considered a STEAM activity because it combines elements of science, technology, arts, and mathematics disciplines. Op Art often relies on principles of visual perception and psychology, which are elements of science. Op Art relates with technology in that Op Art designers use technology to manipulate shapes, colors, and patterns to achieve the desired result (Mercat et al., 2017). Mathematics plays a significant role when artists use mathematical principles such as geometry, symmetry, and perspective to create precise and symmetrical patterns and shapes (Brewer, 1999). Furthermore, some calculations are often required to determine the exact measurements and angles needed to create optical illusions. Lastly, considering the art discipline, Op Art is a form of visual art (Parola, 1996). While mathematics is a crucial component in an Op Art design, the primary focus is on creating visually captivating and perceptually challenging artworks that engage viewers intellectually and emotionally. This multidisciplinary approach distinguishes optic art from a purely mathematics activity, primarily focusing on mathematical problem-solving and concepts.

Mercat et al. (2017) stated that Op Art could be used to apply creativity skills in mathematics. While older students could design an Op Art using specified algorithms, younger students could draw or paint a previously produced Op Art in-class activities (Mercat et al., 2017). Likewise, Starko (2013) stated that redrawing a figure is a creative process. While redrawing a previously produced Op Art, students should create a suitable model for the structure of Op Art, identify the basic parts of this model, and comprehend the relations of the determining parts with each other. Thus, the process by which a person creates an Op Art design can be considered a creative process, and the Op Art design is a creative product (Mercat et al., 2017). Therefore, given the creative essence attributed to the process of crafting Op Art designs and the resultant creative products, as posited by Mercat et al. (2017), it is pertinent to introduce the subsequent discussion of the Creativity Diamond model, shown in Figure 2, which was purposefully conceived to scrutinize the intricacies involved in individuals engaging in the creation of Op Art. The development of the Creativity Diamond model was undertaken with the primary objective of investigating the procedural aspects associated with individuals engaging in the creative process of creating Op Art.

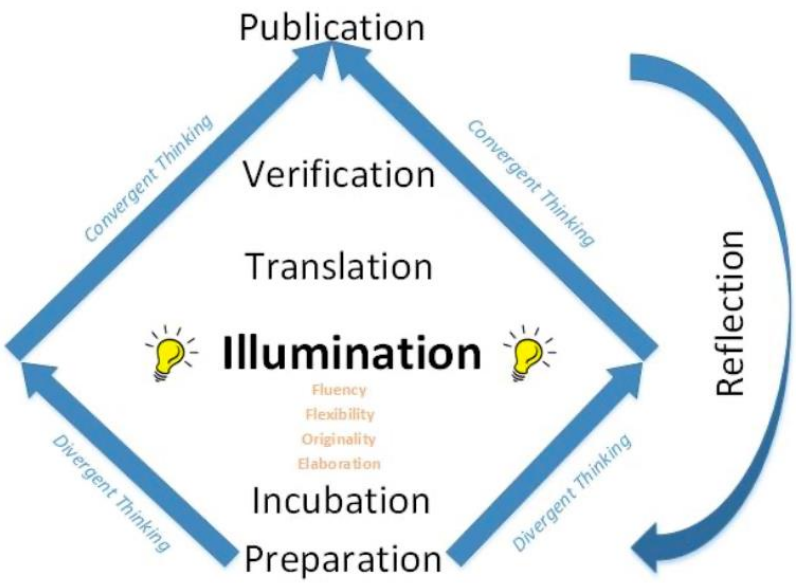


Figure 2 Creativity Diamond Model (Mercat, Filho, & El-Demerdash, 2017)

The Creativity Diamond model was created by integrating and combining various mathematical thinking and creativity theories. This model refers to the creative process that a person uses when solving a mathematical problem. In this model, Divergent Thinking is one of the most important steps and is the part where new ideas are formed. Competencies such as Fluency, Flexibility, Originality, and Elaboration in this step are expressed as follows.

- Fluency: The ability of a person to examine a mathematical problem or situation to develop various ideas about the problem or situation in a short time.

- Flexibility: The ability of the person examining a mathematical problem or situation to develop more than one approach and method toward the problem or situation.

- Originality: The ability of the person examining a mathematical problem or situation to offer original and unique approaches to the problem or situation.

- Elaboration: The person examining a mathematical problem or situation can identify, interpret and generalize the differences in the problem by changing one or more aspects of the problem/situation (Leikin 2009; Leikin & Siriraman, 2017; Mercat et al., 2017; Silver, 1997; Torrance, 1966).

The concepts defined above are included in the Divergent Thinking step and are the competencies that a person applies consciously or unconsciously in the creative process (Guilford, 1950, 1967; Volle, 2017). In the thinking processes, divergent thinking refers to the

mental skill where people can produce many possible solutions or ideas when encountering a problem or challenge. Divergent thinking is unique because there is not just one right answer; it is about exploring various possibilities. The cognitive ability described by Volle (2017) highlights how individuals can explore and develop creative solutions when faced with open-ended problems. The illumination step in the model is defined as the turning point of the model. After this turning point, the Convergent Thinking step comes, and the person creates a form, proof, explanation, program, model, conclusion, etc., against the problem or situation that others can see and evaluate. Sternberg and Lubart (1999) explored the idea of convergent-integrative thinking. This kind of thinking is when people break down a problem into its basic parts and devise a plan to see how these parts fit together. Thinkers who are good at this can discover new links, mix different ideas, find hidden patterns, and create new connections between things that seemed unrelated before (Sill,1996).

In 1966, Torrance developed a Test of Creative Thinking called the Torrance Test. This assessment evaluates creative thinking through tasks involving both written and visual elements. It assesses creativity based on several key factors, including:

1. Fluency: This measures the total number of suitable and relevant responses the test-taker provides.
2. Flexibility: It gauges how diverse the categories of responses are, reflecting the test-taker's ability to approach the task from different angles.
3. Originality: This evaluates the uniqueness and rarity of the responses, highlighting the capacity for innovative thinking.
4. Elaboration: It quantifies the level of detail and depth incorporated into the responses, indicating the richness of the generated ideas.

Therefore, Torrance's test comprehensively examines various dimensions of creative thinking across verbal and visual domains (Leikin & Pitta-Pantazi, 2013).

Method

Research Design

In this study, a qualitative approach, the case study method, was used. Middle school students were asked to produce Op Art designs, in which they could employ creativity, individually or in groups of two, for four different Op Art activities organized by the researchers. The researchers observed this design process, and students' views on the activity

were taken. In this study, the case study was deemed appropriate since it examined how middle school students used their creativity skills while making Op Art designs. A case study is a qualitative research design that examines a specific phenomenon in-depth (Yin, 2017; Zanial, 2007). In this research, the creativity skills of middle school students in the process of designing Op Art were observed. Student opinions were gathered with interview forms and one-on-one interviews, and then the obtained data were examined in detail (Creswell & Poth, 2016).

Participants

The study group of research consists of 28 voluntarily selected middle school students attending a middle school in a province in the Western Black Sea region. The primary criterion employed for participant selection hinged upon the enrollment status of students in middle school grades. Notably, the activities undertaken in this study did not necessitate a grade-specific proficiency in geometry knowledge. Consequently, the grade level of the participants held no significance in the context of this research. Participants were selected by the convenience sampling method, one of the purposeful sampling types. This method brought speed and practicality to the study (Yıldırım & Şimşek, 2013). This study group consisted of 11 male and 17 female students. Six students from this study group were studying at the 5th-grade level, and 22 students were at the 7th-grade level. The actual names of the participants were not used, but S1, S2, …, and S28 codes were given to name them. Op Art activities were carried out by the authors in this study.

Research Context

Within the scope of the current research, researchers studied the history of Op Art, its types, its relationship with creativity, the relationship between Op Art and STEAM, preparing Op Art-related activities, etc., during 12 weeks. The authors in the study prepared four Op Art activities and applied these activities to middle school students. In this respect, famous Op Art designers were examined, and each activity focused on an Op Art designer. For each activity, characteristics of the works made by the Op Art designers and the geometry they used in their designs were identified. The researchers determined the works of designers that could be repeated by a middle school student. The standards included in the Ministry of National Education (2018) Primary and Secondary School Mathematics Curriculum and associated with the Op Art activities prepared within the scope of this study were as follows:

1. Constructs parallel line segments to a line segment and interprets whether the drawn line segments are parallel or not.
2. In cases where a whole is divided into two parts, it determines the ratio of two parts to each other or each part to the whole. In problem situations, when one of the ratios is given, it finds the other.
3. Recognize the center, radius, and diameter by drawing a circle.
    a) *Studies on using a compass are included.*
    b) *The relationship between the circle and the circle is indicated.*
4. Draws two-dimensional views of three-dimensional objects from different directions.
5. Draws the images of points, line segments, and other shapes resulting from translation.
6. Creates the reflection image of a point, line segment, and other shapes.
7. Creates the image of polygons resulting from translations and reflections.
8. Determines the similarity ratio of similar polygons and creates congruent and similar polygons (Ministry of National Education, 2018).

Detailed information about the famous Op Art designers who took part in the events and the event process is given in Table 1.

Table 1 Activities and Processes

Activity	Activity Process
Activity 1	The famous Op Art designer who took part in the event is Victor Vasarely and his works are shown. Within the designs, • Different geometric shapes are included. • Concepts such as translation, reflection, and symmetry are included. Students are asked to create a new unique design by considering the Op Art designs examined.
Activity 2	The famous Op Art designer, Richard Anuszkiewicz, took part in the event, and the works of this artist are shown. Within the designs, • There are different geometric shapes. • Rotation, translation, continuing pattern by reducing the shape in certain proportions on geometric shapes, etc., takes place. Students are asked to create a new unique design by considering the Op Art designs examined.
Activity 3	The famous Op Art designer, Bridget Riley, took part in the event, and the works of this artist are shown. Within the designs, • It has different geometric objects. • Geometric shapes have different colors, sizes, and layouts.

	• A three-dimensional effect was created in a two-dimensional plane by mathematical operations such as translation, reflection, and changing areas. Students are asked to create a new unique design by considering the Op Art designs examined.
Activity 4	The famous Op Art designer who took part in the event is Akiyoshi Kitaoka, and his works are shown. Within the designs, • Circle, square, rhombus, and different shapes are used. • There are illusions such as swelling, mobility, and depth in the designs. • There is a perception of swelling due to the use of geometric objects in different sizes in designs. • Concepts such as translation, reflection, symmetry, and pattern are included in the given designs. Students are asked to create a new unique design by considering the Op Art designs examined.

In addition, the implementation process for each of the activities was similar to the lesson plan used by Boaler (2019) for Mathematics and Art lessons (Figure 3).

Activity	Duration	Description	Materials
Information about op art (infographic)	10 min	• Infographics are shown • Information is given about the famous Op Art artist and their designs to be discussed at the event. • Students are asked to work individually or form groups of two.	Infographic posters
Investigation	20 min	• Students' attention is drawn to geometric and mathematical concepts that can be discovered in Op Art designs. • Students are asked to find mathematical relationships within Op Art designs.	• Copies of Op Art designs, • Colorful pencils • Papers
Creativity	20+ min	• Students are asked to create their own designs using the Op Art design they have examined.	Needed materials to complete design
Discussion and presentation	15 min	• Opinions of the students on the Op Art visuals they designed are taken. • Presentations of designs are made.	

Figure 3 Implementation Process of an Event (Boaler, 2019)

Data Collection

The data collection tools used in the study consisted of the observation form used by the researchers during the activity, the open-ended opinion form answered by the participants, and one-on-one interviews with some students. Details are provided below.

Observation Form

Researchers observed the Op Art design processes and creativity skills of the participants using the observation during the Op Art activities. The form used during this observation is given below. This form was created after revising the form developed by Boakes (2019).

Observation-Evaluation Items	1st Group	2nd Group
Participant Names		
Participation in the event	Yes/ Partially/ No	Yes/ Partially/ No
Students' attitudes towards the activity (positive/negative)		
Explaining the materials used during the design with their justifications (ruler, compass, protractor)	Yes/ Partially/ No	Yes/ Partially/ No
Involve teamwork	Yes/ Partially/ No	Yes/ Partially/ No
Include discussions about the event	Yes/ Partially/ No	Yes/ Partially/ No
Creating an original design at the end of the event.	Yes/ Partially/ No	Yes/ Partially/ No
Expressing geometric shapes used in designs.	Yes/ Partially/ No	Yes/ Partially/ No
Expressing the mathematical relationships in the created designs (I combined three line segments, drew the diagonals of the square, drew parallel lines to each other, etc.)	Yes/ Partially/ No	Yes/ Partially/ No

Figure 4 Observation Form

Open-ended Questionnaire

While preparing questions in the questionnaire, researchers paid attention to the principles, such as questions being understood by the participants, not being multidimensional, and not being directive (Bogdan & Biklen, 1992). Then, expert opinions were received on the questions, and the form was arranged in line with expert opinions. The questions in the form are given below:

1. What are your thoughts on designing an Op Art activity? Please explain.

2. Which picture did you draw in the activity, and why did you choose this picture? Please explain.

3. What method did you use while drawing, and what did you pay attention to?

4. Do you think your drawing was successful? Why?

5. Explain what you like and dislike about the activity.

6. What interested you the most in this activity? Explain why.

7. Would you like these kinds of activities to be implemented in your mathematics lessons? Explain why.

8. What are the things that this activity taught you? Please explain.

One-on-one Interviews

At the end of the Op Art activities, a person from the research team conducted one-on-one interviews with the volunteer participants, and open-ended questions were used during the interviews. Some of the questions frequently used in one-on-one interviews are: Which design did you do at the Op Art event, what did you notice? How did you feel about the design you made? What did you learn? What are your suggestions and criticisms about Op Art events? One-on-one interviews were audio-recorded and then transcribed.

Four Op Art activities were implemented with the participating students, each lasting approximately one hour. At the end of the activities, extra time was given to the students to fill in the open-ended questionnaire. A copy of the students' Op Art designs and the filled questionnaire forms were recorded. After the activities were completed, face-to-face interviews were conducted with volunteer students.

Data Analysis

In the data analysis, the data obtained from the open-ended questionnaire and interviews were evaluated in detail by using the content analysis method. The codes were grouped into categories, and then themes were explored (Yıldırım & Şimşek, 2017). The data obtained from each activity in the study were coded independently by two researchers.

Furthermore, in the research conducted by Leikin and Pitta-Pantazi (2013), a creative thinking assessment originally developed by Torrance in 1966 was incorporated. In this study, we used the assessment to evaluate students' creative abilities in the context of Op Art designs. Specifically, the evaluation encompassed four key competencies: Fluency, Flexibility, Originality, and Elaboration, which were employed to assess the level of creativity exhibited in the students' Op Art creations. In the context of this research, it was imperative to introduce an additional component called the Same. The ensuing section provides a detailed breakdown of these assessments.

• Frequency: The number of Op Art designs produced by the student during the activity.

• Flexibility: The Op Art design was inspired by one of the designs presented to the student. However, the design differs from the original model in color and size.

• Originality: The Op Art design was created by combining two designs presented to the student or using shapes not included in the original model.

• Elaboration: The student completed the Op Art design and presented it to the class. The student interpreted the shapes and differences he added to his own design.

• Same: The student took one of the presented Op Art designs and created the same color, size, and shape (Leikin & Pitta-Pantazi, 2013).

Validity and reliability

The inter-coder reliability was checked by using the agreement calculation belonging to Miles and Huberman (1994) ([Number of codes with consensus/(Number of codes with consensus + Number of codes without consensus)] *100.00). As a result of the analysis for each activity, the percentage of agreement between encoders was calculated between 86% and 93%. These values stood sufficient for intercoder reliability as they provide the minimum value of 85% suggested by Miles and Huberman (1994). The researchers discussed and agreed on the codes where disagreements occurred.

Findings

This research examined the processes of middle school students in Op Art activities and their views on these activities. The data obtained in this study were analyzed by content analysis and presented under two headings: Findings regarding middle school students' Op Art designing processes and findings regarding middle school students' views on Op Art designs.

Findings Regarding Middle School Students' Op Art Designing Processes

The findings regarding the Op Art design process of the students were obtained with the observation forms during the activity and the open-ended questionnaire. In this direction, three themes have emerged regarding the processes of middle school students in making Op Art designs: Mathematical expression, visual expression, and creativity skills. The categories within the scope of these themes are presented below.

The students' findings regarding the Op Art design were obtained with the observation forms during the activity and the open-ended questionnaire. With that regard, three themes have emerged from the processes of middle school students' Op Art designs: Mathematical

expression, visual expression, and creativity skill. The categories within these themes are presented below.

Table 2 shows the findings for the mathematical expression theme.

Table 2 Findings for the Mathematical Expression Theme.

Categories	Students	f
Drawing equal, symmetrical, and parallel lines	S2, S3, S4, S5, S6, S8, S9, S13, S15, S16, S21, S12	12
Use of materials (ruler, compasses, etc.)	S19, S25	2
Use of geometric shapes (square, rectangle, etc.)	S2, S6, S10, S11, S13, S23	6
Similarity and proportion (growth and shrinkage) in geometric shapes	S8, S12	2
Patterning (with colors and shapes)	S27	1

Under the mathematical expression theme, five categories emerged: Drawing equal, symmetrical, and parallel lines (n=12), use of materials (n=2), use of geometric shapes (n=6), similarity and proportion in geometric shapes (n=2), and patterning (n=1).

The findings under the mathematical expression theme were gathered primarily by the responses to the 3rd question, " What method did you use while drawing, and what did you pay attention to?" in the open-ended questionnaire and notes in the observation form. It has been observed that students could easily express which geometric shape they use in their designs and that they could express their designs using mathematical terms. Below, sample statements by students were given.

In the activity, I drew Figure 10 because it looks like the rectangles are intertwined (S12).

The essence of the picture consists of dark colors; I will stick to it. I will make a pattern using red-black, then purple and blue in the first line. I used patterns in the designs I made today (S27) (Fig. 14)

In addition, during the Op Art activity, it was observed that the students used materials to create mathematically correct shapes (Figure 5).

Figure 5 Pictures for Students' Use of Materials.

Findings regarding students' ability to identify and use appropriate materials for design were coded as "yes, partially, no" based on the observation form. In Table 3, it is seen that most of the students could "partially" explain the materials they used in their design.

Table 3 Findings on Material Use

Categories	Codes	Students	f
Can students explain the materials and their justifications while they were used during the design?	Yes	S7, S8, S27, S1, S16, S4, S21, S22, S12, S28	10
	Partially	S15, S2, S5, S6, S13, S14, S18, S19, S20, S23, S24, S25, S26	13
	No	S3, S9, S10, S11, S17	5

The number of students who did not provide any findings regarding material use was 5. These students did not use any materials (rulers, compasses, etc.) during the activities.

The number of students who did not express any opinion on the mathematical expression theme was 10. Students with the codes S1, S12, S14, S19, S20, S21, S22, S24, S5, S16, S22, and S26 expressed their views on the mathematical expression theme only in one activity (Activity 3).

The findings of the visual expression theme are given in Table 4.

Table 4 Findings Regarding the Visual Expression Theme.

Categories	Students	f
Drawing proper lines and shapes	S1, S14, S19, S20, S21, S22, S24	7
Using colors and painting	S5, S12, S16, S22, S26	5
Three-dimensional drawing	S12	1

As seen in Table 4, three categories under the visual expression theme emerged. These categories are: Drawing proper lines and shapes (n=7), Using color and painting (n=5), and Three-dimensional drawing (n=1). S2, S3, S4, S6, S7, S8, S9, S10, S11, S13, S15, S17, S18, S23, S25, S27, and S28 did not present any findings for the visual expression theme. Table 4 shows that most of the students presented findings on Drawing proper lines and shapes. However, one student presented findings in the category of three-dimensional drawing. Below are some students' expressions on drawing proper lines and shapes.

We paid attention to drawing the lines straight (S14).

While drawing, I paid attention to how it grows and shrinks (S5).

While drawing, we tried to be careful while taking the measurements and drawing correctly (S20).

While drawing, we mostly used a ruler so that each line was smooth and the picture looked beautiful (S19).

We paid attention to color harmony and drawing the lines straight (S22).

While drawing, I used the method of having a three-dimensional picture and drawing black and white (S12).

Another theme obtained from students' Op Art design process is the creativity skill theme. The findings regarding the creativity skill theme are detailed in Table 5.

Table 5 Findings on the Creativity Theme.

Categories	Activity 1	Activity 2	Activity 3	Activity 4	Total Frequency
Frequency	f = 2 S25, S26	f = 1 S11	f = 0	f = 0	f = 3
Flexibility	f = 14 S2, S3, S4, S5, S6, S7, S8, S9, S10, S13, S14, S15, S16, S17, S18, S19, S20, S23, S24, S25, S26, S27, S28	f = 13 S1, S3, S4, S5, S6, S7, S8, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S27, S28	f = 6 S3, S9, S10, S23, S24, S27	f = 7 S1, S2, S12, S13, S14, S15, S16, S27	f = 40
Originality	f = 3 S1, S11, S12, S25, S26	f = 4 S11, S21, S22, S23, S24, S25, S26	f = 2 S12, S2, S25, S26	f = 4 S11, S21, S22, S23, S24, S25, S26	f = 13
Same	f = 1 S21, S22	f = 0	f = 10	f = 5	f = 16

		S1, S4, S5, S6, S7, S8, S11, S13, S14, S15, S16, S19, S20, S21, S22	S4, S5, S6, S7, S8, S9, S10, S19, S20	
Elaboration f=4 S6, S7, S27, S28	f=3 S8, S16, S22	f=3 S18, S21, S5,	f=3 S25, S26, S15	f=13

As seen in Table 5, students produced 20 designs in the first activity. S25 and S26 worked together, showed their frequency skill, and developed two designs. When Table 5 is examined, it is seen that most of the students (n=23) made flexible designs (f=14) in Activity 1, while a small number of students (n=5) made original designs (f=3). Figures 6 and 7 show the flexible and original designs made by the students in Activity 1.

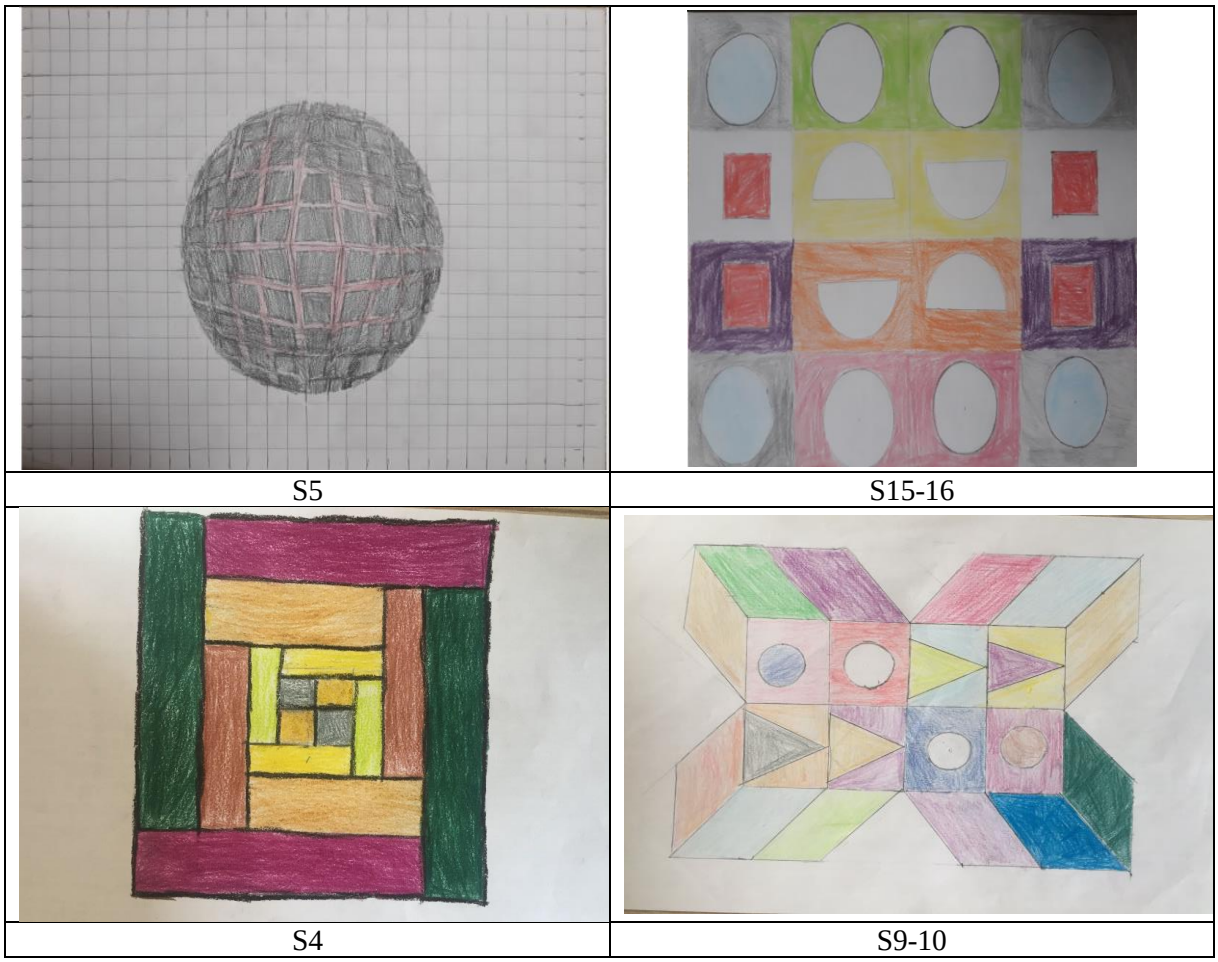
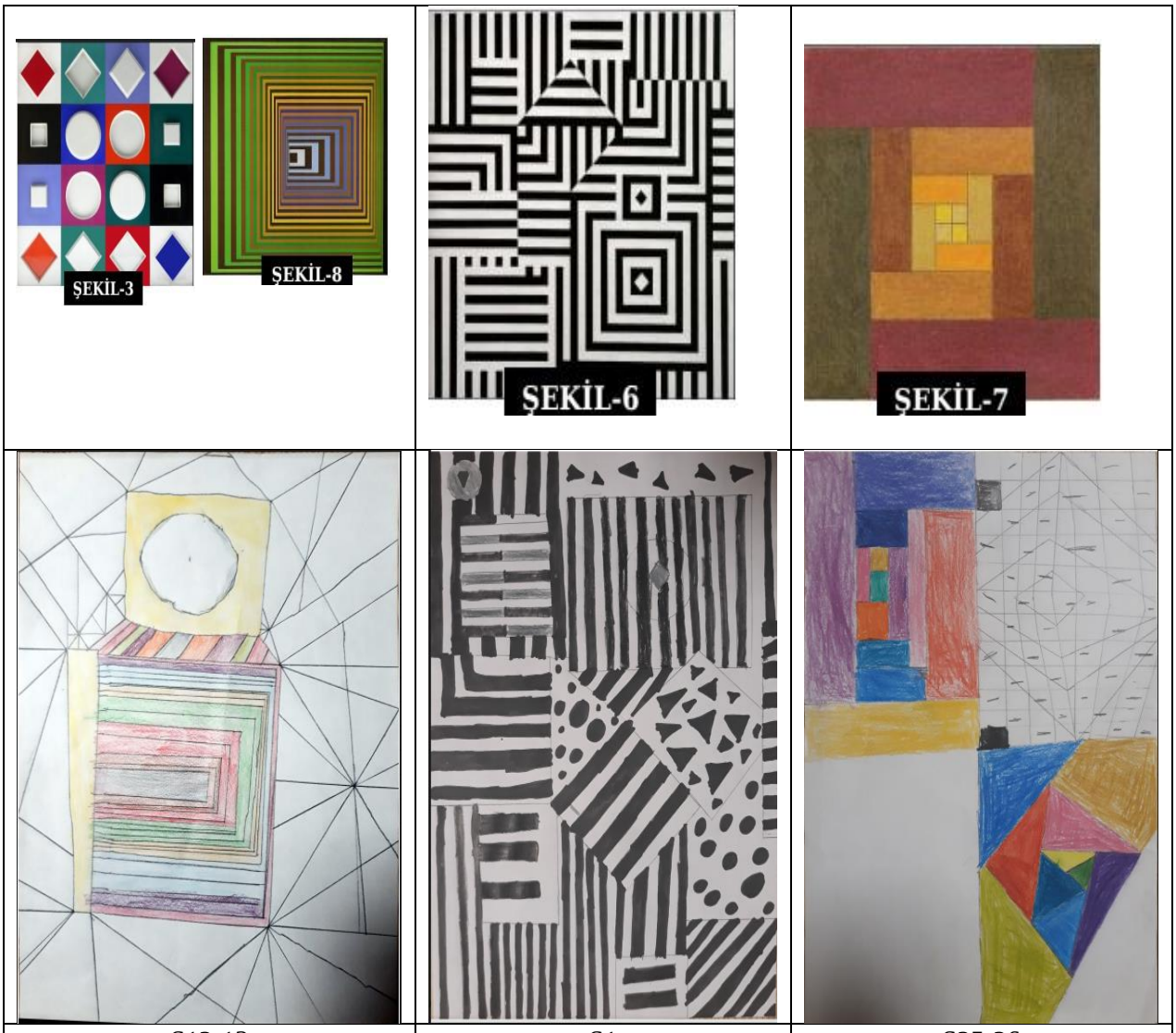


Figure 6 Flexible Designs by Students S5, S15-16, S4, S9-10 in Activity 1.

It has been determined that the designs created by students in Figure 6 differed from the original designs by color and size.



S12-13	S1	S25-26

Figure 7 Original Designs by Students S12-13, S1, S25-26 in Activity 1.

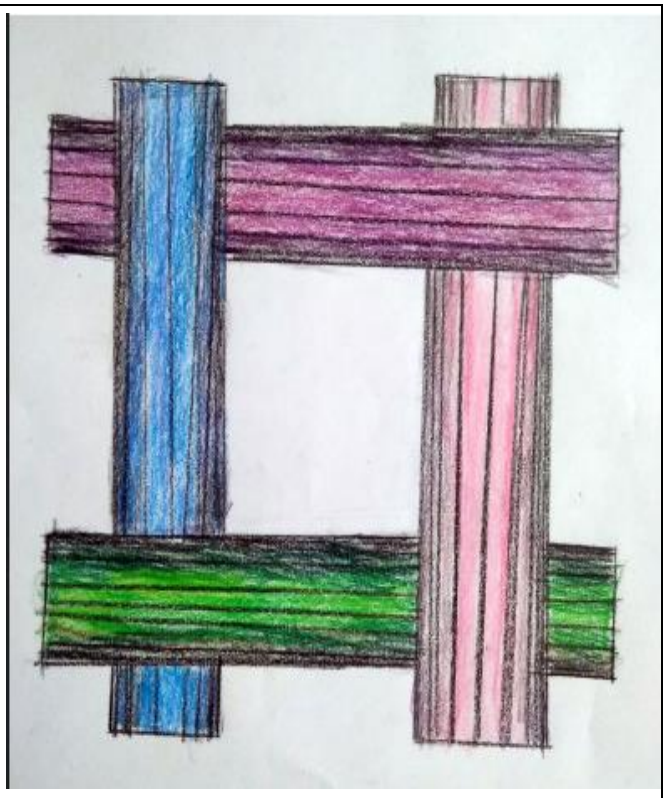
As shown in Figure 7, the students presented different Op Art designs from the Victor Vasarely designs (the images in the first row) presented to them. The students created original designs by combining two different designs presented to them or integrating different geometric shapes into the existing design (Figure 7).

When Figure 7 is examined, S12-13's Op Art design differs from the work presented to them in terms of size and geometric shape. The students also included different geometric shapes (various triangle and quadrilateral shapes in the background of the Op Art design), which were different from the work presented to them. S1 integrated two different works into his design in a unique way. S25-26 students, on the other hand, showed frequency skill in their designs. While showing flexibility in one of their designs, they redesigned the same design by using different geometric shapes (triangles) and produced original work. While in

the original design, the depth perception was given with rectangles, in their design, students tried to give the depth perception by using triangles.

As shown in Table 5, most of the students (n=20) made flexible designs (f=13); however, few students (n=7) made original designs (f=4) in Activity 2. S11 demonstrated frequency skills and produced two designs. Figure 8 and Figure 9 show sample flexible and original designs made in Activity 2.

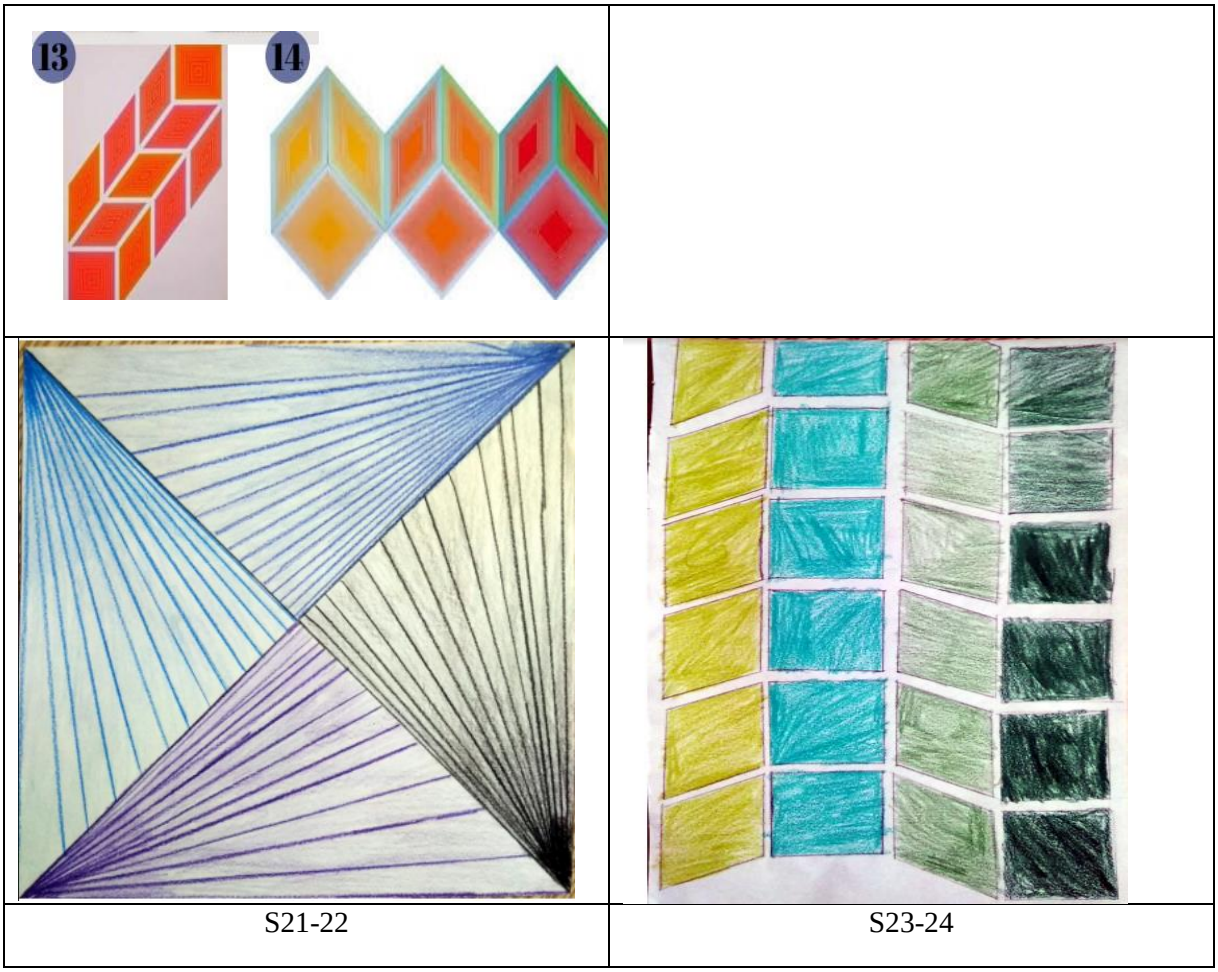
S19-20



S7-8

Figure 8 Flexible Designs by Students S19-20 and S7-8 in Activity 2.

It has been determined that the students' designs in Figure 8 differed from the original designs by color and size.



S21-22 S23-24

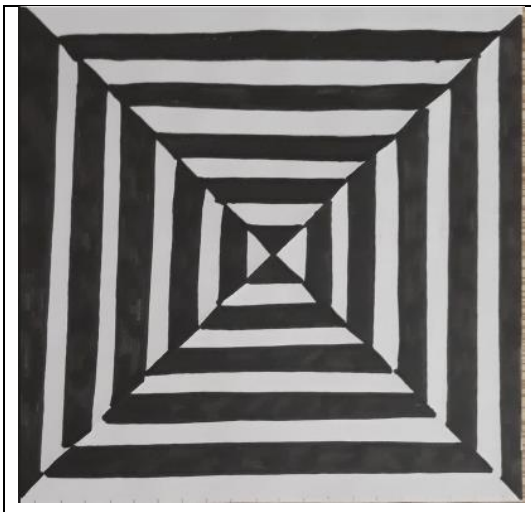
Figure 9 Original Designs by Students S21-22 and S23-24 in Activity 2.

In Figure 9, it is seen that the students produced an original design or brought together two different designs presented to them. S21-22 made an original study by changing the form presented to them. S23-24, on the other hand, interpreted the direction of depth perception in their designs differently compared to the original works. In the original work, the cube is observed on the surface. However, the students' works show the rectangles' directions and the depth of the angles.

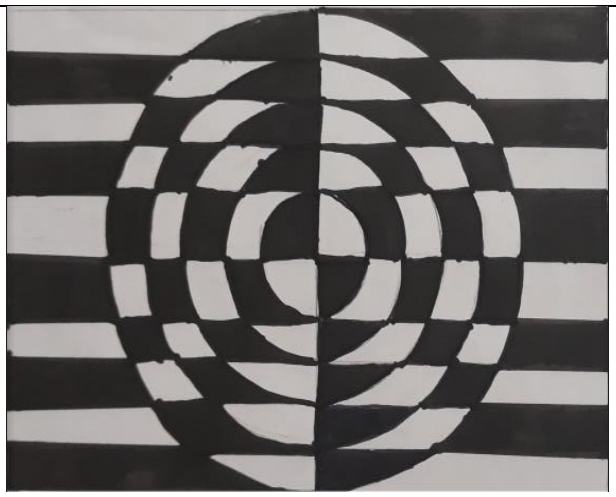
We used lines going from close to wide (S21).

I tried to draw on the same plane as the lines in the original picture (S22).

As shown in Table 5, most of the students (n=15) made the same designs (f=10) in Activity 3. However, a small number of students (n=6) made flexible designs (f=6), and few students (n=4) made original designs (f=2). S11 demonstrated frequency skills and produced two designs. Examples of the same, flexible, and original designs made in Activity 3 are presented in Figure 10, Figure 11, and Figure 12, respectively.



S19-20



S8

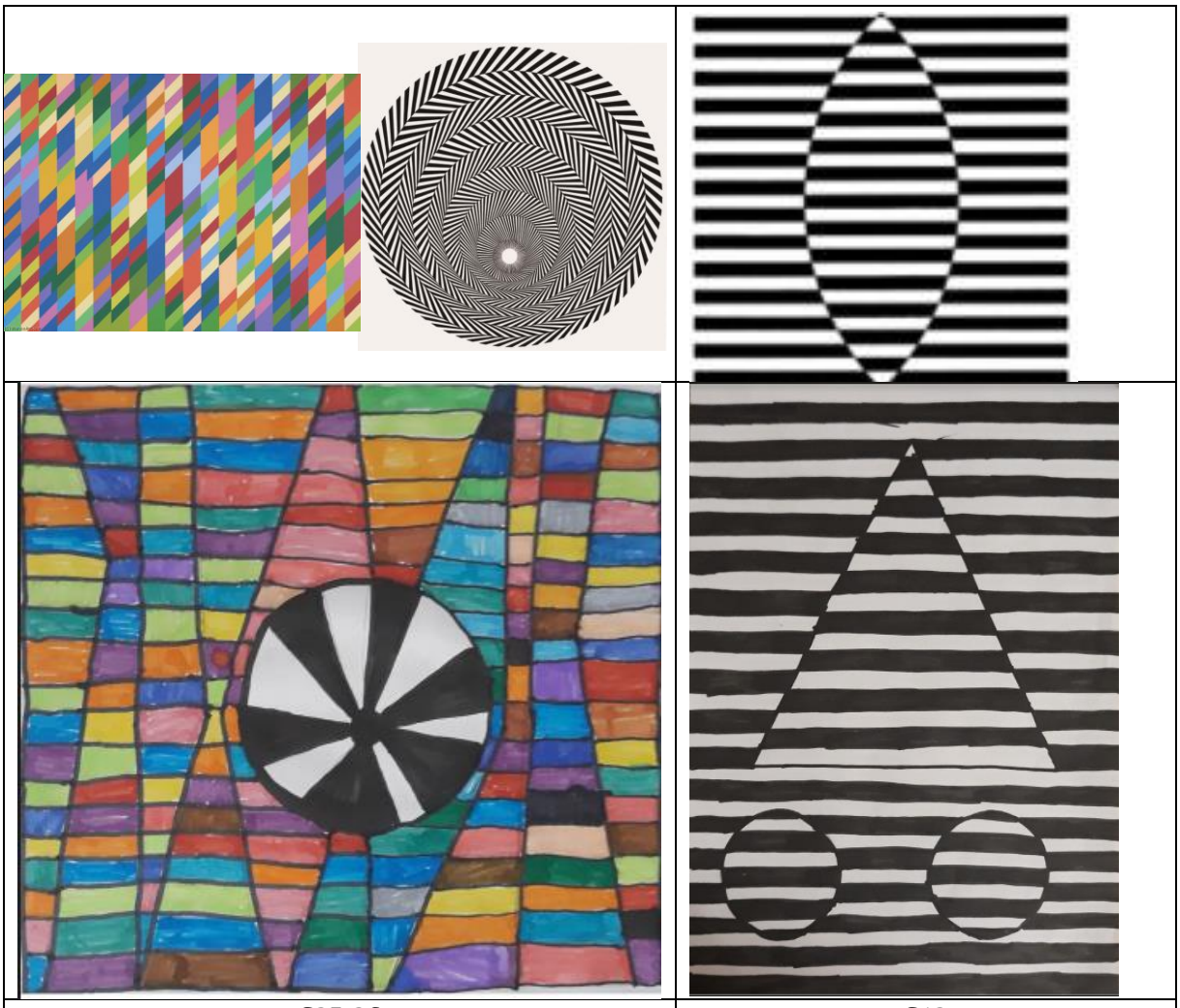
Figure 10 Same Designs by Students S19-20, S8 in Activity 3.

S23-24

S27

Figure 11 Flexible Designs by Students S23-24, S27 in Activity 3.

It has been determined that the students' designs in Figure 11 differed from the original designs by color and size.



S25-26 | S12

Figure 12 Original Designs by Students S25-26, S12 in Activity 3.

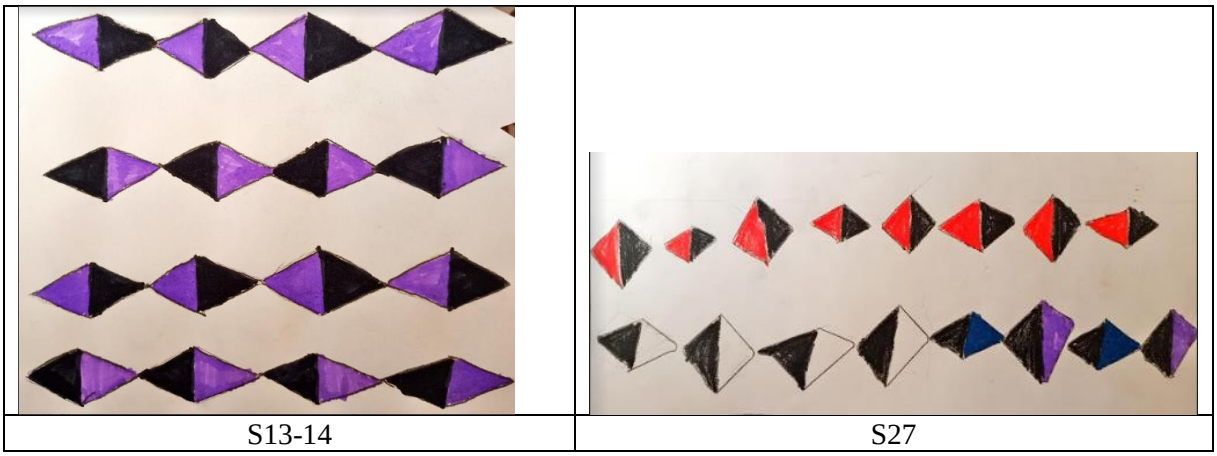
As shown in Figure 12, students combined two designs presented to them or used a geometric shape different from the original one. S25 and S26 were inspired by two different works and created the original design. S12 included geometric shapes (circles and triangles) in his work, which differs from the original work. The created work differs in size and geometric shape from the original design.

Table 5 shows that the majority of the students (n=9) made the same designs (f=5) and flexible designs (n=8, f=7) in Activity 4. However, few students (n=7) made original designs (f=4). Examples of the same, flexible, and original designs made in Activity 4 were presented in Figure 13, Figure 14, and Figure 15, respectively.

S7-8	S5-6

Figure 13 Same Designs by Students S7-8 and S5-6 in Activity 4.

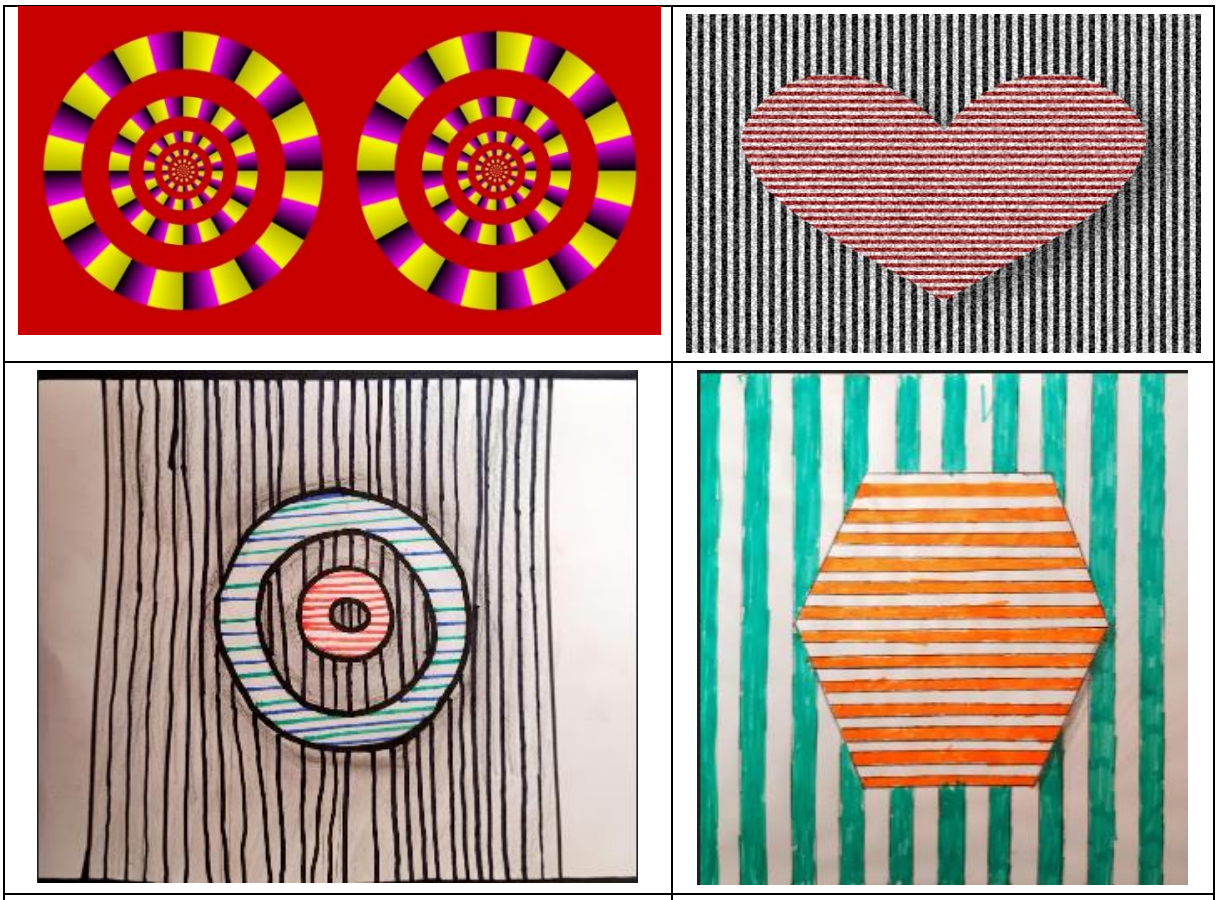
Figure 13 shows that the students made the same designs presented to them.



S13-14	S27

Figure 14 Flexible Designs by Students S13-14 and S27 in Activity 4.

The designs presented in Figure 14 differ only in color from the original designs presented to the students.



S25-26	S21-22

Figure 15 Original Designs by Students S25-26 and S21-22 in Activity 4.

The designs in Figure 15 show that the students combined two designs presented to them or used a geometric shape different from the original design. Ö25-26 created utterly original work in their designs. The students' design differs from the original work regarding color, size, and geometric shape. Similarly, Ö21-22 employed distinct coloring, sizes, and geometric shapes in their designs and produced original work.

Findings Regarding Middle School Students' Views on Op Art Designs

As a result of the students' responses in interviews and open-ended questionnaires, their opinions on Op Art design were gathered. After investigating the students' opinions, six themes occurred: General views on Op Art designs, Liked/disliked aspects of Op Art design activity, the success of the designs made, the exciting aspects of the Op Art activity, the views on the use of Op Art activities in mathematics lessons, instructive aspects of Op Art activities. Table 6 presents the general views of the students about Op Art designs.

Table 6 General Views on Op Art Design.

Categories	Codes	Students	f
Positive views	Nice	S1, S2, S3, S4, S5, S7, S8, S10, S11, S12, S13, S14, S15, S16, S19, S20, S21, S22, S27, S28	20
	Enjoyable	S1, S4, S5, S6, S8, S10, S19, S23, S24	9
	Instructive	S2, S9, S11, S12, S27	5
	Product design	S8, S26	2
	Effective	S25	1
	3D view	S13, S25	2
Negative views	Compelling	S8	1
	Difficult	S8	1
Neutral views	Different, odd	S25	1

As shown in Table 6, three categories emerged regarding the general views of middle school students about Op Art activities: Positive, negative, and neutral opinions. Most of the students reported positive opinions about Op Art activities. Below are sample positive views of some students about Op Art activities.

I think it brought a different dimension to mathematics. I am happy that I discovered this aspect of mathematics and think it was a good activity (S22).

It was beautiful because it encouraged people to think and draw geometry (S27).

On the other hand, few students expressed negative or neutral opinions about Op Art activities.

Table 7 represents the categories and codes related to the Liked/disliked aspects of the Op Art design activity theme.

Tablo 7 Liked/Disliked Aspects of the Op Art Activity.

Categories	Codes	Students	f
Liked aspects	Nice	S1, S2, S5, S6, S7, S9, S15, S19, S20, S21, S22, S23, S24, S28	14
	Exciting	S13	1
	Instructive	S4, S11	2
	Illusion	S8, S14	2
	Researchers' interests in us	S10, S12	2
	Drawing and painting	S3, S12, S16	3
	Materials used	S26	1
Disliked aspects	Difficulty	S18	1
	Time limit	S27	1
Uncertain	Uncertain	S25	1

According to Table 7, 25 students stated their favorite aspects of Op Art activities, two stated disliked aspects, and one used an ambiguous expression. Below are some students' views on the liked aspects of the Op Art design activity.

What I liked about the activity was that it was like an illusion. It makes you feel like you are in it. There are no aspects that I did not like (S8).

What I liked was that we were working in groups. There is no aspect that I did not like (S21).

Table 8 shows the findings regarding the students' successes in Op Art designs.

Table 8 Students' Successes in Op Art Designs.

Categories	Codes	Students	f
Successful	I tried, I worked hard	S1, S16, S18	3
	I cared, drew in detail	S2, S7	2
	I liked	S12, S19, S20, S28	4
	I showed in 3D	S8, S13	2
	I could draw the same shape	S3, S5	2
	I paid attention to mathematical proportions	S4, S8, S15, S27	4
	We worked as a team	S6	1
	I used colors carefully	S9, S26, S27	3
	I completed my design	S21	1
Partially successful	I could not simulate the given design.	S11	1
	I could not paint properly	S25	1
Unsuccessful	I did not like	S10	1

As shown in Table 8, most of the students found their Op Art designs successful, two students found them partially successful, and one student found them unsuccessful. Below are some sample student views.

Yes, successful. Because I could create color animation and parallel edges in the best way (S27).

It was successful because there was depth in it(S13).

Yes. Because I tried to do the exact figure (S5).

I think it was successful. Because I tried (S1).

The subjects that most interested students in Op Art activities are given in Table 9.

Table 9 Attractive Aspects from the Op Art Activity.

Categories	Codes	Students	f
Visuals	Drawing methods	S6	1
	Colors	S8, S10, S11, S12, S15, S16, S23	7
Geometry	Geometric shapes	S3, S4, S25	3
	Having the geometry in the picture	S5, S14, S20	3
Optic illusion	Illusion	S8, S13, S26	3

	Three-dimensional appearance	S11, S28	2
Artist	Methods used by the artist	S1, S2, S15, S22, S27	5
	Artist	S24	1
Materials	Materials used	S19	1
Not attractive	Nothing attractive	S7	1

In Table 9, it is seen that the subjects that attract the attention of most students in Op Art activities are visuals, geometry, optical illusion, Op Art artist, and the materials used. However, it was also found that one student did not find Op Art activities interesting.

The shapes intrigued me. All of them were beautiful and different from each other (S4).

I was most interested in the relationship between painting and mathematics (S5).

Picture. Because I was not very interested in painting before (S6).

I understood that mathematics works in every field (S14).

Connecting figures and pictures to mathematics in a way (S20).

Students' views on using Op Art activities in mathematics lessons are given in Table 10.

Table 10 Opinions on Using Op Art Activities in Mathematics Lessons.

Categories	Codes	Students	f
Yes	Lessons will have more fun	S1, S2, S4, S5, S8, S9, S11, S12, S14, S15, S16, S18, S19, S20, S22, S26, S28	17
	Lessons become instructive	S2, S27	2
	The activity requires math	S3, S6, S13, S15, S23	5
	Our interest in the lesson increases	S8	1
No	I like regular class more	S24	1
	Makes math class harder	S25	1

As seen in Table 10, 25 students want the Op Art activities to be implemented in mathematics lessons, while two students do not. Below are examples of students' views on whether they want Op Art activities to be used in mathematics lessons.

Yes. It can make our lessons more fun (S19).

Yes. I usually struggle with geometric objects, but I can understand better if such happens (S27).

No. Because I am more interested in numbers (S6).

Table 11 indicates the instructive aspects of Op Art activities for students.

Table 11 Instructive Aspects of Op Art Activities.

Categories	Codes	Students	f
Instructive	The relations between painting and geometry	S1, S2, S5, S6	4
	Different use and appearance of shapes	S3, S8, S11	3
	Learned a new Op Art artist	S4, S8	2
	Illusions by shapes and colors (Op Art)	S8, S24	2
	Mathematics is everywhere	S10, S13, S14, S15, S16, S18, S19, S20, S27	9
	Drawing geometric shapes more precisely and accurately	S12	1
	Use of materials (ruler, compass, …)	S12, S21	2
	Drawing, painting, use of colors	S23, S26, S28	3
Not instructive	Did not learn anything	S9	1
	Not meaningful	S25	1

As shown in Table 11, the students generally find the Op Art design activities instructive, and they state that Mathematics can be in many fields. Some students' views on the instructive aspects of Op Art activities are given below.

> *Pictures are misleading. Drawing geometric objects and appearing as if they are not part of the picture (S1).*
>
> *I learned to use geometric shapes more neatly and accurately and use the protractor for a different purpose (S12).*
>
> *I learned that most things are not limited to a single dimension and that there are different dimensions (S22).*

Discussion

In this study, a deliberate selection of Op Art designs crafted by renowned artists, which intricately incorporated mathematical concepts aligned with the middle school curriculum, were selected. Subsequently, students were instructed to replicate these selected designs in the activities. The research undertook a comprehensive examination of both the procedural aspects involved in creating Op Art designs and the perspectives articulated by the students in the process. The data collection involved using observation forms to meticulously record the students' actions and procedures during the creative activities. Additionally, photographic documentation was employed to capture the Op Art designs generated by the students as an outcome of the activities. Furthermore, the research encompassed the solicitation of the students' views through the administration of an open-ended questionnaire.

The outcomes derived from the process of creating Op Art designs revealed that a majority of students demonstrated proficiency in incorporating geometric forms within their Op Art designs. To achieve this, they frequently employed tools such as rulers and compasses to ensure precise construction of these geometric elements. Moreover, congruent with the findings regarding the Op Art design process, the results indicated that engagement in Op Art activities facilitated the cognitive processes associated with conceiving and rendering various geometric configurations such as encompassing parallel lines, intersecting lines, distinct quadrilateral classifications, and circular forms. These activities additionally prompted the application of mathematical principles for the purpose of quantifying alterations made to these geometric configurations. This aligns with existing literature, which posits that Op Art activities offer a conducive platform for acquiring a comprehensive understanding of the fundamental attributes of geometric shapes, exploration of diverse geometric concepts, investigation of symmetry as a concept, manipulation of geometric shape characteristics to achieve visual depth, and acquisition of geometric definitions such as symmetry and similarity (Brewer, 1999; Heskett, 2007).

The present study augments the extant body of literature by investigating the utilization of mathematical principles by middle school students in the context of their Op Art endeavors, thereby enriching the relatively scanty research in this domain. Furthermore, it underscores the significance of Op Art activities in enhancing students' attention towards aesthetic and visual aspects, encompassing precision in geometric rendering, adept handling of color, and the creation of three-dimensional forms. This underscores the proposition that Op Art designs possess the potential to function as a STEAM (Science, Technology, Engineering, Arts, and Mathematics) activity, bridging the realms of mathematics and art, as previously articulated in the works of Çepni (2018), Morari (2023), Ozkan (2022), Perignat, and Katz-Buonincontrö (2019), and Starko (2013).

Upon in-depth analysis of the Op Art designs produced by the middle school students, the investigation identified five distinct categories that pertain to creativity, denoted as Frequency (f=3), Same (f=16), Flexibility (f=40), Originality (f=13), and Deepening (f=13). This outcome resonates with the fundamental objectives of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education, which places a paramount emphasis on nurturing and cultivating creativity skills, as asserted by Perignat and Katz-Buonincontrö (2019).

The process involved in creating Op Art designs, as evidenced in this study, inherently embodies a creative endeavor, and the resulting Op Art products serve as tangible manifestations of creativity, a perspective that aligns with the assertions made by Mercat et al. (2017). Notably, the study revealed that many of the Op Art designs crafted by students exhibited adaptability and originality. Throughout the instructional activities, students were exposed to Op Art designs created by renowned artists in the field, allowing them to emulate these exemplars or formulate their own unique designs. The results indicated that most students opted for the latter, demonstrating their capacity to produce distinct designs.

In essence, these findings underscore the efficacy of Op Art activities as a potent pedagogical tool within the STEAM framework, serving to cultivate and augment creativity skills, a perspective that aligns with the viewpoints articulated by Çepni (2018), Daugherty (2013), Liao (2016), and Perkins (1988).

The present investigation revealed that most of the participating students, totaling 25, expressed favorable opinions regarding the Op Art design activity. Students conveyed that they found the activities to be both engaging and informative, emphasizing their aesthetic appeal. This resonance with student perceptions is consistent with prior studies, which underscores the engaging and instructional nature of Op Art activities, as discussed in the works of Brewer (1999), Heskett (2007), Mercat et al. (2017), and Starko (2013).

Furthermore, a subset of 20 students conveyed a sense of accomplishment in relation to their Op Art designs. They suggested that this sense of achievement was attributed to factors such as diligence, attention to detail, utilization of geometric elements, consideration of mathematical proportions, collaborative teamwork, and the fulfillment of the design process. This observation underscores the discernment that students who perceive their Op Art designs as successful do not solely focus on the ultimate output (i.e., the end product) but also attach significance to the intricacies of the design process itself (Ozkan; 2022; Morari, 2023). This congruence with the multifaceted nature of creative endeavors aligns with the tenets of Vygotsky (2004), who emphasized the integral role of both the process and the outcome in the creative act.

“It must not be forgotten that the basic law of children’s creativity is that its value lies not in its results, not in the product of creation, but in the process itself. It is not important what children create, but that they do create, that they exercise and implement their creative imagination.” (p. 72)

Additional themes extracted from the responses to open-ended questionnaires encompassed the captivating facets of the Op Art activity, its educational value, and the students' perspectives regarding its incorporation into mathematics instruction. The outcomes from these thematic areas illuminated that a substantial proportion of the students expressed a keen interest in integrating Op Art activities within their mathematics curriculum, recognizing its multifaceted appeal and instructional efficacy. Notably, students found the convergence of geometry and optical illusion within Op Art particularly captivating. This facilitated their comprehension of the concept that geometric shapes and their inherent properties could be harnessed to generate three-dimensional or dynamically shifting visual constructs within the confines of a two-dimensional plane, which is consistent with the observations made by Riley (1999).

In the present study, Op Art design activities were administered to middle school students, encompassing a spectrum of geometric shapes and conveying a perceptual impression of depth, motion, and illusion. Subsequently, the study investigated the students' perspectives regarding their Op Art designs and activities. In future research, it is conceivable to integrate Op Art activities within specific mathematical subjects or concepts. After such tailored Op Art activities are developed, the views and experiences of students and educators involved in the instructional process may be assessed.

Conclusions and Suggestions

The primary focus of this study centered on investigating the perspectives and artistic creations of middle school students engaged in Op Art design activities. Specifically, this research incorporated select designs crafted by renowned Op Art artists, integrating mathematical principles aligned with the middle school curriculum. The outcomes revealed that students predominantly formed geometric shapes and employed instruments such as rulers and compasses to ensure precision in their geometric representations. Engagement in Op Art activities significantly contributed to students' proficiency in conceptualizing and crafting diverse geometric configurations. Additionally, it fostered their competence in applying mathematical measurements and effecting alterations within these geometric constructs. Notably, this study extends the existing body of scholarship by delving into how middle school students harness mathematical concepts within the realm of Op Art activities and underscores the potential of Op Art designs as STEAM activities, integrating mathematical principles with artistic creativity.

Regarding creativity, most Op Art designs created by the students exhibited notable degrees of flexibility and originality. The research underscored the capacity of Op Art activities to foster and enhance creativity skills, aligning with the overarching objectives of STEAM education. Furthermore, the students conveyed positive appraisals of the Op Art design activity, characterizing it as engaging and instructive, and appreciating its aesthetic appeal. Moreover, students attributed their accomplishments in Op Art design to various factors, including diligent effort, careful attention to mathematical proportions, effective teamwork, and an appreciation of the design process itself.

Creativity plays a pivotal role in middle school education, and Op Art provides a remarkable avenue for its cultivation within the framework of STEAM education. With its complex interplay of geometric shapes, optical illusions, and aesthetic appeal, Op Art offers students a dynamic platform to explore and express their creative potential. Studying Op Art in middle school can expose students to the captivating world of visual arts and integrate mathematical concepts seamlessly into the creative process. Through Op Art activities, students can engage in designing captivating and mathematically informed visual compositions, which, in turn, fosters the development of creativity skills. This interdisciplinary approach aligns with the goals of STEAM education, which seeks to develop in students the ability to approach complex problems from multiple perspectives and to harness creative thinking to innovate across various domains.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

We have no conflicts of interest to declare.

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Credit author statement

Authors contribution rates: 1st author %40, 2nd author %20, 3rdauthor %15, 4th author %15, 5th author %10

Research involving Human Participants and/or Animals

This study has the Bartin University Ethics Committee Approval Document; date: 30.12.2020, protocol number: 2020-SBB-0283.

Ortaokul Öğrencilerinin Op Art ile Matematik Deneyimleri ve Yaratıcılık Becerileri

Özet:

Bu araştırma ortaokul öğrencilerinin Op Art tasarımlarını ve tasarım etkinlikleri hakkındaki görüşlerini araştırmayı amaçlamıştır. Araştırma kapsamında, öğrencilere dört farklı Op Art etkinliği uygulanmıştır. Veri toplama aracı olarak gözlem formu ve açık üçlü anket formu kullanılmıştır. Ayrıca öğrencilerin görüşlerini detaylı bir şekilde elde etmek için birebir görüşmeler yapılmıştır. Toplanan veriler içerik analizi yöntemi kullanılarak analiz edilmiştir. Öğrencilerin Op Art tasarımları frekans, esneklik, özgünlük ve ayrıntılandırma becerilerini içeren yaratıcılık elması modeli kullanılarak analiz edilmiştir. Analizlerin sonucunda matematiksel ifade, görsel ifade ve yaratıcılık becerileri gibi üç temel tema ortaya çıkmıştır. Bu temalar, Op Art etkinliklerinin öğrencilerin matematiksel ve görsel ifade becerilerini geliştirdiğini ve yaratıcılık gelişimlerine katkı sağladığını göstermektedir. Ayrıca, öğrencilerin Op Art tasarımlarına verdikleri yanıtların analizi sonucunda Op Art tasarım etkinliğine dair genel görüşler, beğenilen ve beğenilmeyen yönler, oluşturulan tasarımlara dair başarı algıları, Op Art etkinliğinin heyecan verici yönleri, matematik derslerinde Op Art etkinliklerinin kullanımına ilişkin görüşler ve Op Art etkinliklerinin öğretici yönlerini içeren altı tema ortaya çıkmıştır. Bu çalışma, Op Art etkinliklerinin öğrencilerin yaratıcılık becerilerine, özellikle de esneklik yeterliklerine katkıda bulunabileceğini ve öğrencilerin sonuç ile beraber sürecin de önemli olduğunu keşfetmelerine yardımcı olacağını vurgulamaktadır. Bu bulgular, Op Art etkinliklerinin matematik derslerinde öğrencilerin matematiksel ve görsel ifade becerilerini ve yaratıcılık becerilerini geliştirebileceğini göstermektedir.

Anahtar kelimeler: matematik, geometri, op art, ortaokul öğrencileri, yaratıcılık

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