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Address
Afyon Kocatepe Üniversitesi, Eğitim Fakültesi, A.N.S. Kampüsü, 03200 Afyonkarahisar, Turkey
Tel: +90 272 2281418
e-mail: editorkebd@gmail.com

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FROM THE EDITOR

Dear Distinguished Researchers and Readers,

We are here with the last issue of 2021. In this issue, you will find 10 research articles of 23 authors from different disciplines. We hope that these articles will contribute to the literature.

Due to the high number of submissions, we need to select best papers meticulously for the review process and reject the manuscripts that are not in line with the journal criteria. These criteria are expected to increase quality and decrease reviewing length. For this issue, the average time from submission to acceptance was 4.4 months (min. 2 months max. 7 months), and the average time from submission to publication was 6.7 months (min. 5 months max. 8 months). These statistics prove how our reviewing and publication process works equally for everyone.

Finally, we should also express our sincere thanks to the Editorial Board, reviewers and authors for their invaluable contributions. As you see in the following pages, 112 reviewers from 5 different countries and 62 different institutions contributed to the issues of 2021. Although this is a faculty journal, just 7 of these reviewers were from Afyon Kocatepe University. We will endeavor much more to internationalize our journal.

We look forward to receiving submissions of sufficient rigor and quality. We wish you good health and hope to meet again for the 2022 January issue!

Fatih GÜNGÖR, PhD
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Faculty of Education

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A Testopia during COVID-19: Qualitative Study about Higher Education Institutions Examination (HEIE)

COVID-19 Sırasında Bir Testopya: Yükseköğretim Kurumları Sınavı (YKS) Hakkında Nitel Araştırma

Aylin SALTÜRK* **Ömay ÇOKLUK-BÖKEOĞLU****

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ABSTRACT: Central exams are in the heart of Turkish education system since they are used for student selection and placement in transition to higher levels of education. The preparation process for central placement exams, which was already challenging for students and parents, may have become even more exhausting due to the changing educational paradigms during the COVID-19 pandemic. In this context, using the phenomenological model, this study aims to determine the student and parent views regarding the preparation for the Higher Education Institutions Examination (HEIE) during COVID-19 pandemic period. Semi-structured interviews were conducted with 20 high school seniors in an Anatolian High School in Afyonkarahisar Province during the 2020-2021 academic year, selected with the purposive sampling method, and of their parents, and the obtained data were analysed through content analysis method. Although stress is an ordinary part of the preparation period, new stress sources have formed during the pandemic, according to the findings obtained from this study. It has been seen that both the students and the parents have discussed higher visibility of socio-economic inequalities, limited student life experience, impacts of social isolation due to the implemented health and safety policies as *the cons*, and the opportunities to study harder and more autonomously as the *pros*. Parents have also evaluated children's being under their supervision during this period as one of the pros.

Keywords: Higher Education Institutions Examination, COVID-19 pandemic, admission exams.

ÖZ: Merkezi sınavlar seviyeler arası geçişte öğrenci seçme ve yerleştirme için kullanıldığından dolayı Türk eğitim sisteminin temelinde yer almaktadır. Doğası gereği öğrenci ve ebeveyn için zorlayıcı bir deneyim olan merkezi yerleştirme sınavlarına hazırlık süreci, COVID-19 hastalığı neticesinde değişen eğitim paradigmaları ve hastalığın bir pandemiye dönüşmüş olmasının getirdiği sorunlar nedeniyle daha da yıpratıcı bir hale gelmiş olabilir. Bu bağlamda fenomenolojik desenin kullanıldığı bu araştırmada COVID-19 pandemisi sürecinde merkezi yerleştirme sınavlarından biri olan Yükseköğretim Kurumları Sınavı'na (YKS) hazırlanmaya ilişkin öğrenci ve ebeveyn görüşlerinin belirlenmesi amaçlanmıştır. Amaçlı örnekleme yöntemiyle seçilen, 2020-2021 eğitim öğretim yılında Afyonkarahisar'da bir Anadolu lisesinde 12. sınıfa devam eden 20 lise öğrencisi ve onların ebeveynlerinden oluşan çalışma grubuyla yarı yapılandırılmış görüşmeler gerçekleştirilmiş ve elde edilen veriler içerik analiziyle çözümlenmiştir. Stres, birçok öğrenci ve ailesi için sınava hazırlık sürecinin normal bir parçası olsa da araştırmadan elde edilen bulgular COVID-19 pandemisiyle birlikte yeni stres faktörlerinin devreye girdiğini göstermiştir. Hem öğrencilerin hem ebeveynlerin *olumsuzluklar* olarak sosyo-ekonomik eşitsizliklerin daha görünür hale gelmesini, sınırlı öğrencilik deneyiminin, uygulanan sağlık ve güvenlik politikaları nedeniyle sosyal izolasyonun etkilerini; *olumlu* unsurlar olarak daha fazla ve özerk çalışma imkânı olmasını ele aldıkları görülmüştür. Ebeveynler aynı zamanda bu süreçte çocuklarının kontrolleri altında olmasını da olumlu bir sonuç olarak değerlendirmiştir.

Anahtar kelimeler: Yükseköğretim Kurumları Sınavı, COVID-19 pandemisi, giriş sınavları.

* Res. Asst., Afyon Kocatepe University, Afyonkarahisar, Turkey, asalturk@aku.edu.tr, https://orcid.org/0000-0003-4143-8917
** Prof. Dr., Ankara University, Ankara, Turkey, cokluk@education.ankara.edu.tr, https://orcid.org/0000-0002-3879-9204

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According to the data of Turkish Statistical Institute (TurkStat), young population (aged between 15-24) constitutes 15.6% of the total population in Turkey (TurkStat, 2019). While this situation may be an advantage for a developing country, it also brings along some problems regarding the education of the population in question (Baştürk, 2011). Looking through a historical point of view, there are a number of chronic problems associated with education in Turkey, just like in every other developing country. Most of these problems are related to frequent changes in the education system (Temli-Durmuş & Kasa, 2015) and unequal opportunities in education (Günbayı et al., 2015; Kumandaş & Kutlu, 2014). In this regard, among the factors feeding unequal opportunities, schools showing significant differences from each other in terms of equipment and physical conditions (Çıngı et al., 2009), teacher qualifications and inadequate employment in schools (Ayvacı et al., 2014), sociocultural factors such as the environment (Coşkun, 2019) can be indicated. It is possible to see the reflections of unequal opportunities in the statistical data provided by Turkish Ministry of National Education (MoNE, 2020b), where schooling rate remains far below what it should be, and dramatic discrepancies exist in the success of the students in the exams for transition to higher levels. Within this context, education-related problems become the problem of not only the students but also their parents, namely, the whole society.

The fact that transition to higher education is based on examination (Yılmaz & Altınkurt, 2011) is one of the major problems, also defined as *"the festering sore"* (Arslan, 2004, p. 37), of Turkish Education System. An education system based on the central placement exam puts parents in trouble as well as students (Köse, 1999), and young people in this system get caught up in test booklets before they can experience their developmental period (Rutz & Balkan, 2015). Additionally, this exam is far from providing feedback on the education (MoNE, 2010, as cited in Büyüköztürk, 2016, p. 349). Since these exams have grown into almost a *'struggle for existence'* for both students and parents, students are raised as individuals deprived of skills to facilitate their lives and to be test-oriented only (Büyüköztürk, 2016). In this process, parents also try to get their children to receive academic support by sending them to extracurricular institutions to the extent possible (Gür et al., 2013; Tansel & Bircan, 2005).

The problems of exams (Çelik, 2015; ÖSYM, 2017), employed for placement in higher education institutions and whose applications, scope and name have changed frequently from 1974 to the present (Gür & Çelik, 2009) have remained the same. Considering students' struggles to move to the next level of education and overcome unequal opportunities and negative effects resulting from such struggles on them (Büyüköztürk, 2016; Cüceloğlu, 2013; Karslı & Üstüner, 2001; Kutsal & Bilge, 2012), it would not be wrong to state that these exams go beyond their purpose and that the primary purpose of education determined in the Basic Law of National Education (1973), has deviated from the goal of *'ensuring a healthy and productive adaptation of the young population to the society'*.

Evaluating on a global scale, the education systems of different countries indeed have their own strengths and weaknesses. In parallel with the development level of the countries, it is seen that success in education has also increased. Technological developments have been integrated into education at full speed. At the same time, COVID-19 pandemic emerging in 2019 caused a global crisis due to rapid morbidity and mortality statistics (Tabish, 2020), with health and education being the leading

sectors affected. Efforts to contain the epidemic and flatten the pandemic curve have brought along decisions to turn educational institutions into a (semi or full) state of closure. This undoubtedly has led to the serious disruption of the education sector, especially in certain countries (Malee-Bassett & Arnhold, 2020).

With the announcement of the first COVID-19 case in Turkey on March 11, 2020, the need for a two-week break to education arose. It was decided to continue remote education at all levels through online systems throughout the Spring semester (MoNE, 2020a; YÖK, 2020). Although plans for implementing hybrid education (blended learning) model were made for the fall semester of the 2020-2021 academic year, the plans were revised to continue online education with the primary and secondary education institutions due to the increase of the cases once again (MoNE, 2020a). Additionally, a similar proposal was made to higher education institutions within the framework of health and safety policies. As a result, the situation, beginning as a health crisis, soon affected the functioning of all systems in the society, leaving no option but to quickly move to distance education, irrespective of suitable infrastructure in education. At the beginning of the process, distance education was stated not being as efficient as face-to-face education; however, some of these views evolved with the arrangements made in time and some empirical research findings have been revealed about the positive results of distance education (Hodges et al., 2020).

Educational activities implemented remotely and online since almost the first day of the first COVID-19 case came up to date have reemphasized unequal opportunities and revealed unjust conditions of the students lacking necessary technical infrastructure to access the educational platforms (Saltürk & Güngör, 2020). The inequalities in question were not limited to the access to courses. They stood as problems in terms of assessment and evaluation activities conducted for other purposes. In other words, distance education has inevitably become part of the new education paradigm while efforts have been made to ensure rapid integration of technology to implement assessment and evaluation processes (OECD, 2020). However, it is known that even the use of state-of-the-art infrastructures cannot prevent some technical problems that may occur during e-tests or several factors that may pose a threat to the validity and reliability of the tests (Chirumamilla et al., 2020; Hillier et al., 2020). Therefore, many educational institutions have tried to create equal environments and conditions by applying face-to-face exams (Dermo, 2009; OECD, 2020). It can also be considered that this situation arises as a necessity to secure equal opportunities in countries like Turkey, where inter-school differences are greater because it is impossible even to think of the participation of some students, who cannot join courses due to lack of technical means, in tests synchronically implemented. These tests should not only be considered limited to the exams for evaluating course success within the scope of formal education, but also central and large-scale exams that are the subject of this study should be considered. Given high participation rates in these exams and the repercussions of socio-economic inequalities, it is clear that implementing central placement examinations, being an important determinant of educational life, in an online environment is impossible. Indeed, central examinations planned to be implemented in 2020, for these reasons, were conducted as traditional paper and pencil tests, though belatedly, during the period when the pandemic was relatively taken under control within the framework of health policies (MoNE, 2020a; ÖSYM, 2020a).

It is seen that Higher Education Institutions Examination (HEIE), which has significant impacts on such stakeholders as students, teachers and parents even under normal conditions in Turkey, being a *"Country of Tests"* (Baş & Kıvılcım, 2019, p. 642), is likely to be more problematic due to the changing conditions with the pandemic. Thus, it was considered that analyzing the impacts of the exam in question in line with the views of the students and parents was of importance and to that end, answers to the following questions were sought:

1. How do students and parents evaluate the impact of pandemic on students during the preparation period for HEIE?
2. As for the concerns of both students and parents,
    a. What are their concerns related to HEIE?
    b. Have they changed during COVID-19 pandemic?
3. What do students and parents say about the advantages and disadvantages of the preparation period for HEIE during COVID-19 pandemic?

Method

Ethical Procedures

Before the research, the authorization of *Committee of Scientific Research and Publication Ethics for Social Sciences and Humanities* in Afyon Kocatepe University was sought and granted (decision no 2020/216 dated 20/11/2020). Participants were explained the purpose of the research as well as being provided with such information and assurance as the fact that the participation was voluntary, that their rights to withdraw from the research at any stage resided, that privacy of the identity information and anonymity would be protected, and that the information provided would only be used within the scope of a scientific research study. After such information, the consent of the participants was obtained, and interviews were conducted.

Research Model

This research study used a qualitative research model (Merriam, 2009), which deals with how people make sense of their experiences. The analysis of preparation period for central placement examination during COVID-19 pandemic based on the experiences of the students and parents complies with the phenomenological model. The findings obtained through *phenomenological model*, which allows in-depth evaluation of individuals' perceptions and views (Büyüköztürk et al., 2018), are based on subjective experiences of participants (Denzin & Lincoln, 1998). This model, where the results are provided in a descriptive narrative method with direct speech reporting, allows for understanding participants based on their *'own expressions'* (Patton, 1980, p. 22). The information obtained from the data is interpreted within the framework of themes and codes (Yıldırım & Şimşek, 2011).

Study Group

This study aimed at interviewing people who would provide rich data in terms of preparation for HEIE during COVID-19 pandemic. To that end, *the purposive sampling method (Patton, 2002) was used to determine the study group, where people to contribute more for* this study were included. As was also stated by Patton (2002), *the*

*purposive sampling method is used in cases when there are limited sources in relation to a phenomenon subject to research. T*his method is eligible for determination and selection of cases enriched with the information required for the research. Thus, this method was used in this research study as a data collection method. At the first stage, being a student preparing for the exam and being a parent of these students were accepted as the preconditions of participation in this research. In addition, some characteristics such as strong self-expression skill, being accessible and volunteering were also considered. However, as it was further evaluated that students who were preparing for the exam to re-take it in the status of graduate could have different experience than those in the senior years of their high school education, the former were not included in the research. Data collection continued until the collected data was deemed sufficient in terms of quantity and diversity of the information it included in terms of the gender and success status of the students who continued their education in the 12th grade of high school and prepared for HEIE during the pandemic process as well as socio-economic level, gender, age of their parents.

The research data was collected following the decision dated November 23, 2020, taken for the second time on the implementation of distance education (MoNE, 2020a) due to the increase in COVID-19 cases. Within this context, it was decided to include in the study group the 12th-year students during the 2020-21 academic year, continuing their education remotely because of COVID-19 pandemic and preparing for HEIE, along with their parents. Data was collected from a total of 40 participants, including 20 students studying in an Anatolian High School in Afyonkarahisar Province and their parents *through interviews*. To ensure anonymity, each student (such as S1, S2, S3) and parent (such as P1, P2, P3) were given codes.

13 out of 20 students in the study group are female while 7 are male and their ages are between 17 and 18. The study group members' grade point averages (GPA) range between 68 and 92 out of 100. The ages of a total of 20 parents range between 38 and 55. Two of the parents are fathers, while 18 are mothers. 14 of the mothers are housewives. Parents' education levels vary between primary school and university.

Data Collection

Since the interviewing is recommended as the main data collection tool (Büyüköztürk et al., 2018) within the scope of phenomenological model, a *semi-structured interview form,* including five open-ended questions, was used in this study to identify the views of the students and parents directly in a detailed manner. These questions are related to the evaluations by the students and parents about the impacts of COVID-19 pandemic on the preparation period for HEIE , to whether their concerns have changed in time with the pandemic and to their evaluations about the advantages and disadvantages of preparing for the exam in this period. Upon the creation of the draft form, two experts, who completed their Ph.D. in the fields of education programs and training as well as guidance and psychological counseling, were told the purpose of this research and their opinions were received in relation to the interview form. The experts recommended that the questions including "a reason why" be structured as open-ended questions, which would enable students to answer the questions by having more in-depth considerations on the situations they would be in and that two of the questions be removed from the form as they would not serve the purposes of the

research. In line with these opinions of the experts, necessary revisions were made and the forms were finalized for implementation. The pilot implementation was carried out with the participation of three students and three parents, bearing similar characteristics to those in the study group, at the end of which interview forms were finalized.

The interviews were conducted via teleconference due to COVID-19 pandemic. To ensure the anonymity of the participants, each participant was connected to the teleconference programs, the interviews were recorded only as audio, and video recording was not available. In order to prevent students from feeling as if they had to agree with their parents and to ensure that they could express themselves well in the interviews where parents and students were together, individual interviews were held online with them in a way to ensure that first students then their parents would be separately interviewed. Interviews took place at different times in accordance with the convenience of the students and their parents. A total of forty different sessions were held, once for each student and parent. At the beginning of the interview, participants were explained the purpose of the research as well as being provided with such information and assurance as the fact that the participation was voluntary, that their rights to withdraw from the research at any stage resided, that privacy of the identity information and anonymity would be protected and that the information provided would only be used within the scope of a scientific research study. After such information, the consent of the participants was obtained, and interviews of approximately 25-30 minutes were conducted. After completing all the interviews, the records were transcribed in writing and shared with the participants for confirmation.

Data Analysis

For the analysis of the data obtained from the study, the *content analysis* technique was employed to make replicable and valid inferences from texts and similar important materials (Krippendorff, 2004). A categorical system reflecting basic elements in the relevant text through content analysis is created by *deduction* (theoretically produced based on the literature) or *induction* (produced based on the data set). If the purpose of a study is revealing findings, the use of induction method is recommended. Within this context, the data were analyzed with an inductive iterative process in this study, as suggested by Braun and Clarke (2006). As suggested by Patton (1999), the expertise of a different expert working in the field of qualitative data analysis than the researchers was benefitted from. The academician in question completed his Ph.D. in the field of Education Programmes and Training. With the analysts whose expertise was used during the data analysis process, authors who completed their Ph.D. in the field of Assessment and Evaluation in Education and who was continuing their Ph.D in the field of Educational Psychology coded the transcripts individually at first, then worked together to refine the preliminary themes and create the main themes. Analysis process was carried out with cyclical and continuous comparisons (Glaser & Strauss, 1967) made in the form of *code development/refinement* and *theme development/refinement*. In the end, final themes were introduced as an output of discussions on analysts' comments (Richards & Morse, 2013). As suggested by Bree and Gallagher (2016) and Meyer and Avery (2009), *MS Microsoft Excel* program was used for the data analysis. Popular software such as NVivo, MAXqda, ATLAS.ti, CAQDAS, which are used in data management and were designed to

organise unstructured qualitative data (Zamawe, 2015), are tools having a supporting nature only. In addition, as Faherty (2010) stated, only the researcher can analyze qualitative data. Although each software has different pros and cons in terms of data management, MS Word tables and MS Excel macros are also preferred in qualitative data analysis (Bree & Gallagher, 2016; La Pelle, 2004; Meyer & Avery, 2009). Since coding is a critical step in analyzing qualitative data (Ose, 2016), qualitative data analysis was carried out using MS Excel in this study because it allows systematic coding in a simple and user-friendly manner.

Trustworthiness

As the qualitative research studies are not based on statistical calculations due to their nature (Brink, 1991), they are often criticized for being subjective, lacking a systematic structure, and deficient reporting. In this regard, the criteria to increase the quality of the data in the qualitative research are discussed in the literature (Guba, 1981; Lincoln & Guba, 1986; Maxwell, 1992). Examining these discussions, it is seen that such concepts as *credibility* and *transferability* replace the concepts of validity and reliability in qualitative research studies (Corbin & Strauss, 2007; Eisner, 1991, as cited in Creswell, 2013, p. 246). To increase the *conclusiveness* (internal validity) of the data in this research, necessary sampling scale for phenomenological model was achieved (Charmaz, 2011; Creswell, 2013; Merriam & Tisdell, 2016). Data collection tool, data collection and analysis were reported in detail, by which *transferability* (external validity) of the research was tried to be ensured (Yıldırım & Şimşek, 2011). Data analysis was conducted independently with an expert on qualitative data analysis other than researchers (Patton, 1999). After finalizing the themes and codes, the *percentage of agreement* was calculated as suggested by Miles and Huberman (1994), and the resulting percentage (92%) was found to be sufficient for coding reliability (Miles & Huberman, 1994).

Findings

The research findings have been presented under five categories in parallel with the sub-objectives of the research. In the descriptions of categories, themes, sub-themes, codes, and frequencies of these codes have been given successively for students and parents. In terms of the clarity and simplicity of the findings obtained from the research, the most striking views related to the codes in each category are presented directly with quotes.

Findings of the Impact of COVID-19 Pandemic on the Preparation Period for the Exam

The views of both students and parents collected in relation to the impacts of COVID-19 pandemic on the preparation period for the exam have been interpreted under two main themes, namely *"Impacts"* and *"Coping Strategies"*.

"Impacts" Theme

Under *"psyco-social"* sub-theme within the scope of this theme, students mentioned their health concerns raising in line with the pandemic (*f*=5), *social isolation* (*f*=2) they have experienced as a result of health and safety policies, *extreme stress* (*f*=2) as well as *feeling of emptiness* (*f*=2). Under *"Educational"* sub-theme, students

mentioned *reduced motivation* (*f*=11), *uneasiness caused by lack of doing different activities* (*f*=1), *distractibility* (*f*=1), *inefficacy of online education* (*f*=8), *lack of a structured educational environment and support* (*f*=9) as negative impacts while they mentioned *flexible time* (*f*=2) facilitated by the changing education paradigm as a positive impact of the pandemic.

> "I *felt empty*. People are dying, everything has been shut down. How can we be expected to study efficiently..." (S13)
>
> "We don't know what hit us, we can't go out to *breathe or distract ourselves*, we are with the same people caged within four walls. We can't be with the people we love, which affects us significantly." (S4)
>
> "It ruined everything. Knowing that I have to study for the exam while *there are already problems and distress caused by the pandemic* decreases the determination to study even more. *Hearing that something is happening to the people around* causes an increased *feeling of emptiness* and hinders studying for a certain period." (S1)
>
> "It affects me negatively *as I can't get face-to-face education*. The higher the *fear of losing my relatives* is, the lower my motivation gets." (S7)
>
> "In fact, the pandemic *gave extra time*, but the distress and fear caused by it were quite enough. I lost my motivation to study because *one of my family members went through a difficult time right before my eyes*. The *fear of infection* has caused a lot of distress". (S11)
>
> "Being at home most of the time *gave me the opportunity to study harder*, but also the *school closures* affected me badly. The pandemic lowered my motivation. There are people at home with chronic conditions. I couldn't get anywhere because I was afraid that *if I got sick, I would infect them. Being at home all the time* disrupted my psychology, I became depressed." (S12)

Under *"Impacts"* theme, the parents mentioned, similarly to the students, *health concerns* (*f*=2) and stress (*f*=2) as well as referring to *psycho-social impacts*, differently from the students, such as *uncertainty* (*f*=1), *difficulty in adapting to the process* (*f*=1), *lack of activities* (*f*=1). Furthermore, parents pointed out, just like students did, to the *inefficacy of online education* (*f*=3), *low motivation* (*f*=8), *problem of distraction* (*f*=2), by also referring additionally to *"Educational"* impacts such as *deprivation of educational environment and support* (*f*=13), *lack of discipline imposed by school* (*f*=1), *opportunity to study harder* (*f*=1) and *lack of studying /giving up studying* (*f*=1).

> "It affected badly. The student got even more stressed. *Being away from his/her teachers and friends*, restrictions..." (P4)
>
> "I am thinking about my child. I'm afraid s/he'll get sick, stressed out. *The restrictions* limited my child's *life in many ways*, which, in turn, stresses him/her out and *overwhelms him/her*..." (P11)
>
> "Because s/he's always at home, *s/he devotes more time to her/his lessons*, but *s/he's distracted* and not very enthusiastic." (P16)
>
> "I think the pandemic affected badly. We cannot fill the *gap of face-to-face education* no matter what we do. As *their social lives* have come to a halt, s/he *forces her/himself to study continuously*... S/he was not a child who liked staying at home, so *her/his motivation decreased*..." (P5)
>
> "It affected badly. S/he experienced the *problem of distraction*. S/he doesn't sit at a desk, *even if s/he does, s/he cannot study*." (P10)

"Coping Strategies" Theme

The student and parents also mentioned *"Coping strategies"* related to the fight with the impacts apart from the impacts of COVID-19 pandemic on the preparation period for the exam.

Under the *"Strategies"* sub-theme, it has been seen that students adopted such ways as *dreaming* about the university/profession they wanted (*f*=1), *self-motivating* by thinking that their rivals were in the same situation as them (*f*=1).

> "...I try to study by *thinking that as everybody has been going through the same psychological process*, if I study harder, I can turn this situation into an advantage." (S4)
>
> "...to increase my motivation, I *think about my future profession*, and *dream about it*, so I can study." (S9)

As for the parents, they stated, under *"Strategies"* sub-theme that they had limited means to support their children due to *social isolation* (*f*=8), but they did all they could to *provide moral support* (*f*=9), that they helped children in *planning the process for their studies* (*f*=1).

> "...I, most of the time, *try to drive my child to picnic areas* to improve his/her motivation. While s/he does test, I read a book." (P5)
>
> "...I am trying to *do what s/he likes* for the sake of the family itself, as well." (P11)
>
> "...we have explained him/her that s/he is not the only one being in this situation, which applies everybody preparing for the exam, and the pandemic should not affect him/her motivation. *We have talked to him/her and helped in making his/her plans and programs*. To restore his/her motivation to study, we have done intra-family activities, and by *buying various gifts*, *course materials and tools*, we have tried to help him/her restore his/her motivation." (P12)

Findings Related to the Most Concerning Issues about the Exam

While student views on the most concerning issues about the exam were collected under two main themes, namely *"Educational"* and *"Psycho-social",* it was identified that parents, additionally, expressed their views under *"Health"* theme.

"Educational" Theme

A significant part of the students expressed such fears, under *"Examination system/period"* sub-theme, as *failure to complete the exam questions on time* (*f*=5), *failure to understand subjects all by himself/herself during online education* (*f*=4), *mind blanks* (*f*=2), *being late for the exam* (*f*=1). Under *"Educational outputs"* sub-theme, students expressed their concerns about such potential consequences as *obtaining low scores from the exam* (*f*=1), and *failure to pass the exam* (*f*=10).

> "*The examination system*, all by itself, is my reason for fear. I am afraid of being inadequate. (S6)
>
> "I have started to worry about whether I can understand the subjects and *learn them all in time*." (S9)
>
> "I think that *online education is inefficient* during the pandemic. I am worried because all these subjects will constitute the contents of the exam questions." (S16)
>
> "I already think that I will fail to be placed in a university as a result of the exam, but still *getting low scores worries me."* (S1)
>
> "I am afraid of *forgetting what I know due to stress* and failing to complete the exam questions on time." (S10)
>
> "I am *afraid of failure*." (S11)
>
> "I am afraid of forgetting everything because of stress and *failing to complete exam questions* on time." (S14)

A significant part of the parent concerns was related to *"distance education"* sub-theme. Within this context, the parents expressed their views about their doubts of the effectiveness of online education (*f*=3), the length of the process (*f*=1) and their

children's deprivation of teacher support (*f*=1). Under *"Academic motivation"* sub-theme, parents pointed out to the *lack of motivation* experienced by their children (*f*=1) and to the *insufficient effort* made by the children (*f*=1), accordingly in terms of studying. Similar views of the parents to the students were categorised into *"Educational outputs."* In this regard, parents expressed their *concerns about their children's failure* (*f*=10) by reasoning it with *the worry that students might not learn all the subjects in time and complete the exam questions on time* (*f*=2).

> "The course of the pandemic; if the virus continues to spread rapidly and the courses continue via *distance educatio*n, what if my child receives an *education of poor quality*, lacks good education." (P13).
>
> "Pandemic affected children badly. There is a *disconnection* between children and school and classes, my child lost his/her enthusiasm because of the *disinterested* and unsupportive teachers. We are in contact with my child's teachers, and I think deep down that my child *will not be able to succeed*." (P9)
>
> "I am concerned about what if s/he got stressed and *could not answer the questions*. If *s/he experiences a mind blank and cannot complete the exam questions on time*, both s/he and we will become sad." (P15)

"Psychosocial" Theme

Students not only suffer from educational problems related to the exam but also have some concerns within the *"Psycho-social"* context. Some concerns, especially, fall into the scope of *"Environmental"* factors such as *family pressure* (*f*=2) and of *"Personal"* factors such as *failure to become financially independent* (*f*=1), *efforts to go down the drain* (*f*=1), *concern for future* (*f*=1), *failure to achieve goals* (*f*=2) and *failure to be placed in a university* (*f*=2).

> "Increased *family pressure* due to concern for future worries me a lot. *Concern for future*, will I be able to be placed in a university, will I be able to find a job even if I get my degree, all of these are question marks in my mind." (S4).
>
> "...I am afraid of my *family's pressure* and my *efforts to go down the drain*." (S7)
>
> "I am concerned about *failing to achieve my goals* and be placed in a university." (S18)
>
> "I have concerns such as looking to others and *being dependent for my living*." (S8)

As for the parent concerns within *"Psycho-social"* context, they include their children's getting excited and stressing out (*f*=5) and *"Personal"* factors such as children's *getting upset* (*f*=1). Additionally, parents were identified to have fears such as their children's being *influenced by their friends* under *"Environmental"* factors (*f*=1) and *concerns for future* (*f*=2) similar to the students.

> "The most concerning issue about the exam is *our child's stress condition*. S/he feels too much under stress and we worry *that s/he cannot take his/her stress under control* during the exam." (P12)
>
> "…I also *worry about my child's being influenced negatively by his/her friends*." (P3)
>
> "*Concern for future* and whether s/he ends up being unemployed or not worry us every single day." (P14)

"Health" Theme

Unlike students, parents have concerns about *"Health"* aspect of the examination. The views of the parents concerning about physiological and psychological impacts of the exam were evaluated under *"Pandemic"* sub-theme, and it

was observed that they have *health concerns* and *health problems* (*f*=1) related to COVID-19.

> ''…and the *pandemic preoccupies me''* (P1).
>
> "What if something happens to *wear my child out physiologically or psychologically*." (P5)
>
> "Because of the pandemic, I'm worried about *virus infection* in such a crowded examination environment." (P11)

Findings on Changes in Exam-Related Concerns during COVID-19 Pandemic

Student and parent views on the changes in their concerns emerging during COVID-19 pandemic were grouped under two main themes, namely *"Stable"* and *"Changes"*.

"Stable" Theme

Student views under *"Stable"* theme have showed that students had the same concerns in relation to the exam before the pandemic (*f*=17), which did "*not change at all"*. On the other hand, it has been observed that some students expressed that their already existing concerns became *more overwhelming and greater*, that is, *"Increased"* in line with the pandemic (*f*=3).

> "My concerns *did not change*." (S13).
>
> "I had *the same concerns* before the pandemic because changing examination system is the biggest factor bothering me." (S17).
>
> "Even before the pandemic, I had *the same concerns*, but *they were only a few* because my motivation was higher then." (S1)
>
> "Even before the pandemic, I had *the same concerns*, but *they were not so overwhelming*. I used to think that I could catch up and prepare by receiving support. However, I don't feel so, now." (S18)

A similar situation has also been observed in the case of parent views. The findings have revealed that most parents *had the same concerns* (*f*=14); thus, their concerns did *"not change at all"* and others expressed that the same concerns became *more overwhelming and greater*, that is, *"Increased"* (*f*=1).

> "Even before the pandemic, we had these concerns (referring to the stressful temperament of his/her child). We have *the same concerns*, now, as well. I can say that *we are even more concerned*." (P12)
>
> "I had *the same concerns* about the exam before the pandemic." (P15).

"Changes" Theme

Under *"Changes"* theme, student views expressing that they did not have the concerns before the pandemic they currently have were included. Within this context, it was that some of the student concerns are related to *"Educational"* factors and that students pointed out to *lack of educational support* (*f*=4), *motivational problems* (*f*=1) and the *examination system itself* (*f*=1) as the problem. Moreover, some students expressed their concerns in relation to *"Educational outputs"* such as *failure to achieve goals* (*f*=1).

> "Before the pandemic, I didn't have any fear of catching up with exam subjects or *my capability to succeed because there were people that could be of help*, I could ask my questions to both my friends and teachers, but now, I am all alone." (S9)

> "Even before the pandemic, I had the *same concerns*, but they were *not so overwhelming*. I used to think that I could catch up and prepare by receiving support. However, I don't feel so, now." (S18)

> "No, I did not have the *same concerns*. Before the pandemic, I was worried if I can't go to the university that I aimed for; however, I am almost certain about it because *I can't do this without support*, I can't catch up." (S20)

It has been established that parent concerns differed within *"Educational"* and *"Psycho-social"* contexts in line with the pandemic. In this regard, parents stated that they had fears related to *efficacy of distance education* (*f*=2), *lack of sufficient educational support* (*f*=1), and *their children's failure* (*f*=4) within the scope of their *"Educational"* concerns, whereas, differently from the students, they expressed concerns within *"Psycho-social"* context by referring to their children's *being influenced by their friends* (*f*=1), *health concerns* (*f*=3), *getting stressed* (*f*=2) and *becoming unhappy* (*f*=1).

> "I am afraid *s/he won't get in a university and will become unhappy* because he can't study at home as efficiently as the period before the pandemic." (P6)

> "My concerns were the same then, but when the education evolved to be distance education, I started to concern about *my child's not getting as efficient education as before*." (P2)

> "Before the pandemic, only my child's own stress used to upset me, but now there is also the *risk of this disease*. (P11)

> "Before the pandemic, I was worried that my child would not take the exam seriously. That he's completely *disconnected from the process* and *depressed* concerns me now." (P20)

> "Before the pandemic, I used to worry mostly about the result that my child will get out of the exam, but now, *his/her stressed condition at home* worries me even more." (P13)

Advantages of Preparing for the Exam during COVID-19 Pandemic

Students and parents addressed the *"Educational"* and *"Psycho-social"* advantages of preparing for the exam during the pandemic.

"Educational" Theme

Students expressed, under *"Autonomy"* sub-theme, that exiting a system structured against their will with COVID-19, provided them with more *time* (*f*=2) and *freedom* (*f*=5). They expressed, under *"Physical factors",* that they happened to have a *more comfortable studying environment* (*f*=4), that there were *fewer distracting factors* (*f*=1), and that *they got less tired* (*f*=4) than before.

> "Staying home, studying more comfortably and *freer*." (S19)

> "I had *more time*, which was an advantage for me." (S13).

> "There are no *distractions* such as commutes, friends." (S1)

> "The advantage is that as we are home, we are *not tired from school or extracurricular courses*, in turn, we can study at ease." (S18)

> "It had only one advantage, yes. I *don't get tired or lose time* because of commuting between school and private tuition courses..." (S20)

It has been observed that most of the parents interpreted children's h*aving a better opportunity to stud*y (*f*=4) as the only educational advantage and their related views were analyzed under *"Time"* sub-theme.

> "S/he has *more time for her/his own*. S/he has a space for an efficient studying activity, we do our best to make him more comfortable at home." (P6)

> "S/he *doesn't lose time* while commuting between home and tuition." (P9)

"I think s/he has *more time* to study, to devote to her-/himself and his/her lessons." (P12)

"Psychosocial" Theme

Students pointed out to *"Environmental"* factors such as *reduced motivation of their rivals* (*f*=3) and *"Personal"* factors such as having *time for family* (*f*=1) as the psychological advantages of preparing for the exam during the pandemic.

"… it allows me *more time to spend with my family*." (S7)

"Most *people gave up* and if I don't give up, I can do very well." (S2)

"While everybody cares about the virus, *if I care only about the exam*, I can get ahead." (S3)

"Everybody will be affected by this situation, and *lose their motivation*, and if I can try to keep myself out of it, I can turn this pandemic into an advantage." (S4)

The advantages parents expressed within *"Psycho-social"* context were related to their control and supervision of their children. In other words, parents expressed that with the decrease in *free time spent outside* (*f*=8), they found *the opportunity to follow and supervise their children more easily* (*f*=4), which represents an important advantage within the scope of *"Behavioural control";* and that with the increased time spent at home, *peer influence got reduced* (*f*=1), which represents an important advantage under *"Psychological control"*.

"S/he is *not influenced by his/her friends*.'' (P3).

"It's a good thing s/he's *under my supervision*." (P7)

"We are *able to plan and supervise his/her studying* at home better." (P10)

"It's *easier for me to follow him/her* because s/he's always in my sight at home." (P13)

"…As s/he cannot go out much, *I can check whether s/he is studying or not*." (P15)

"S/he has *more free time* at home. S/he can *devote time to studying*." (P20)

Disadvantages of Preparing for the Exam during COVID-19 Pandemic

Student and parent views on the disadvantages of preparing for the exam during pandemic were analyzed under three main themes, namely *"Physical", "Psychological"* and *"Educational"*.

"Physical" Theme

Under *"Physical"* theme, students pointed out to *insufficient activities* (*f*=2), *risk of getting down with the virus* (*f*=1), *obligation to stay home all the time* (*f*=3) as the disadvantages in relation to *"Health"*.

"...Staying home *demoralizes me*." (S3).

"After all, *health is more important than anything*, losing it affects our entire lives." (S11)

"Being *under constant stress*." (S12)

It has been observed that parents, similarly to the students, expressed their *"health"* concerns. Apart from their *health concerns related to COVID-19* (*f*=1), it has been seen that parents also worry about, differently from the students, the fact that preparation period itself for the exam has *negative impacts on health* (*f*=9).

"As s/he needs to go to private courses, we are afraid of *virus infection*." (P16)

"His/her *health was adversely affected* in every sense." (P6)

"My child is badly affected *both emotionally and healthwise*." (P10)

"Psychological" Theme

"Psycho-social" disadvantages were addressed within the scope of the views expressed under *"Psychological"* theme, under which students mentioned *longing for the past time, where this virus did not exist* (*f*=1), *getting stressed* (*f*=2) and *limited social circle* (*f*=1).

"*Longing,* friends' circle, *lack of activity*..." (S7)

"I am *bored of lack of any activity*." (S8)

Parents, similarly to the students, discussed *"Psychosocial"* disadvantages and pointed out to students' *deprivation of social interaction* (*f*=2) and *feeling depressed and difficulty* (*f*=6); however, differently from the students, they also mentioned that children experienced difficulty *in adapting to the process* (*f*=1) and that this process *caused uncertainty* (*f*=3).

"It has *multiplied the stress* of my already stressed child. As I worry about anything negative that may happen to him/her, I think it is a disadvantage." (P12)

"As we don't know the course of the situation, *adaptation period to pandemic took long*, which led my child to miss classes and, in turn, lack of knowledge about subjects. (P9)

"S/he became *mentally depressed* and ended up to fail in focusing attention, being home all the time." (P15)

"Educational" Theme

As "Educational" disadvantages, most of the students pointed out "Distance education" and the problems encountered due to its very nature. *Lack of face-to-face education* (*f*=4), *failure to understand the subjects by studying all by oneself* (*f*=2), *inefficacy of online education* (*f*=4), *lack of sufficient educational support* (*f*=9) was expressed as the disadvantages of this period. Additionally, differently from parents, students mentioned disadvantages related to "*Academic motivation"* such as *decreased studying rates* (*f*=2), *lack of motivation* (*f*=2), *rivals' studying harder* (*f*=2).

"…I *can't have immediate answers to my questions*, and *studying in the same environment with my sibling* is challenging" (S7).

"As I have *hard time in understanding the subjects taught on distance education*, I lose more time." (S9)

"It is disadvantageous because I think *receiving face-to-face education is more effective* in terms of learning and understanding" (S19)

"Being caged within four walls *demotivates m*e." (S1)

"Everyone has a lot of free time, and for me, it becomes a disadvantage *if everyone focuses more on the lessons.*" (S4)

As for the parents, they discussed, similarly to the students, the problems encountered due to the nature of distance education under *"Educational"* disadvantages. Within this context, parents stated, under *"Distance education"* sub-theme, that students *lost motivation* (*f*=1) and suffered from the *lack of educational support* (*f*=2) as well as discussing their *doubts about the efficacy* of distance education (*f*=2) and students' *deprivation of the opportunities yielded by face-to-face education* (*f*=3).

"In terms of *low motivation*, this period is far more disadvantageous." (P13)

"Due to the restrictions, I can't do my best for my child, nor can I provide necessary *support*." (P1)

"I cannot provide the opportunity for tuition or other courses than school to *support my child's education*." (P3)

"…s/he *cannot learn efficiently* from distance education." (P19).

"S/he *cannot put the education received in full practice*." (P20).

Discussion

It has been challenging for both educators and students to meet the usual standards of *Higher Education Institutions Examination* (HEIE), which is an exam concerning millions of students in Turkey and implement HEIE in accordance with the public health policies coming up with COVID-19 pandemic. As noted in UNESCO's report (2020), countries have adopted various strategies for high-stakes exams like HEIE during COVID-19 pandemic, such as canceling, postponing, rescheduling, and organizing the exams on an online platform. At first, Turkey postponed HEIE and decided that HEIE would be held when contained social life would be in effect (UNESCO, 2020). Although it was a challenging task, it can be stated that HEIE implemented in 2020 by the traditional paper and pencil method was carried out successfully with all personal protection measures and security put in place. However, the findings obtained from this study show that this is a difficult situation to adapt to for students to enter HEIE in 2021 and for their parents. Within this context, the findings of this study are discussed below under four main headings in the light of literature.

Impact of COVID-19 Pandemic on the Preparation Period for the Exam

Evaluating the findings of this study about the impact of COVID-19 pandemic on the exam preparation process, it is seen that both students and parents discussed psychological and educational impacts. In this context, it has been determined that students and parents similarly expressed health concerns, problems caused by low motivation, extreme stress and distraction problems. Uncertainty about the restoration of normal life increased stress and anxiety in both parents and students (Daniel, 2020). Evaluating the findings in terms of differences between the student and parental perspectives, it has been seen that the students expressed that they found it pointless to study for the exam during such a difficult time and that they felt emptiness while parents expressed the lack of discipline imposed by school. When an individual's world turns upside down due to something as chaotic as COVID-19, it can result in the individual thinking that their work is petty or even completely pointless (Martela & Kent, 2020). In this context, it is quite an ordinary reaction for students to question the meaning of them studying through these difficult and unusual times. However, finding a purpose in such situations makes it bearable for the individual (Martela & Kent, 2020). As a matter of fact, the findings have also shown that students strive to be motivated by thinking about their desired profession or their rivals in order to fight against negative impacts of COVID-19 pandemic on the preparation period for the exam. In a sense, this can be interpreted as students trying to reduce the negativity caused by the period by reminding themselves of their goals. Findings have revealed that parents' coping strategies were quite different from those of students. It has been determined that parents expressed that they helped their children make studying plans and provided moral support within restrictions due to public health policies and limited social opportunities. According to a study on high-stake exams conducted by Barksdale-Ladd and Thomas (2000), it was seen that while some parents expressed that they helped their

children by using methods such as preparing them a rich breakfast during their preparation period for the exam, others expressed that they supported their children by pressuring them to complete their study or providing additional educational materials.

The Most Concerning Issues about the Exam

Due to the lack of a structured school/educational environment, the lack of opportunities offered in traditional formal education, infrastructural incapacity and the lack of strategies and materials used in education, students and parents are skeptical of the efficacy of distance education (Başaran et al., 2020). Indeed, the most concerning issues regarding the exam for the students and parents were the efficacy of distance education and the problems caused by the very nature of distance education. In addition, the students also expressed their concerns on the constant changes made to the examination system as well as the process and the consequences of the exam while the parents were concerned about their children's academic motivations in addition to the examination system. The findings obtained from this study show similarity to the findings in the studies conducted before COVID-19 pandemic, in which the constant changes made to Turkish education system were considered a major problem (Temli-Durmuş & Kasa, 2015). For example, in a study conducted by Karataş (2020), students stated that the changes made to the date of the central placement exam during COVID-19 pandemic negatively affected their motivation and psychology.

The findings have shown that the most concerning issues about the exam were not only associated with educational problems and their potential consequences. Both the students and their parents were concerned about some psycho-social factors that were personal and environmental. Because of the infection risk of COVID-19, parents, unlike students, expressed health concerns specific to current time period. It was observed in a study conducted by Yörüsün (2020) that just as there were students concerned about getting infected before the exam, there were also students concerned about getting infected during the exam and then infecting their families; however, there have been no findings in the literature about the views of the parents concerning this issue. It is also known through literature that students experience physical and psychological problems (Abrams et al., 2003) such as anxiety, stress and fatigue due to reduced physical and social activities such as hobbies and art etc. (Lewis, 2003; Thomas, 2005) during the preparation period for high-stake exams. Indeed, it can be seen in this study that some parents' health concerns were not only limited to COVID-19 but also related to these physical and psychological effects, which are in the very nature of the preparation period of the exam.

The findings of this study have shown that the most concerning issues about the exam included failure to be financially independent, efforts to go down the drain and the results of the exam according to the students while the parents were the most concerned about their children' experiencing more anxiety and stress, becoming unhappy and too susceptible to peer influence. Both students and parents expressed their *concerns about the future.* It is known that being part of an exam-oriented education system brings unhappiness (Altan, 2017) and that having constant test anxiety has negative physical and psychological effects on students (Dönmez, 2017). In this regard, it can be stated that COVID-19 pandemic makes the negative effects of an exam-oriented education system even more pronounced. Assessing how to recalibrate well-established curricula

and evaluation traditions upon the pandemic makes it necessary to discuss the advantages and disadvantages of insisting on traditional assessment and evaluation practices. Even though exams constitute an important part of education, their clear association with the curriculum, far less effectiveness compared to global education systems and failure to meet the requirements of the time have made their presence questionable in the rapidly changing educational paradigm with COVID-19 pandemic. Considering that COVID-19 pandemic has made unequal opportunities even more pronounced (Saltürk & Güngör, 2020) for students preparing for HEIE, it seems understandable that students preparing for the exam with limited opportunities and their parents have concerns for the future. It can be considered that concern for the future is also associated with the sociodemographic possibilities of students. This situation can be described as follows: *"Just as families from middle-upper social classes pass on their economic and cultural savings to their children, families from lower social classes pass on their "concerns for the future" and "lack of self-confidence" to theirs."* (Buyruk, 2008, p. 83)

Changes in Exam-Related Concerns during COVID-19 Pandemic

Examining the changes caused by COVID-19 pandemic on concerns about the exam, it has been found out that a great number of the students and parents stated that the concerns they expressed on the previous question did not change at all and others stated that while their concerns did not change, they became more visible and overwhelming. On the other hand, some students and parents expressed changes in the content of their concerns with the pandemic. The hyper-arousal caused by COVID-19 pandemic may have led to an increase in both general and specific concerns about the exam (Karataş, 2020). As a matter of fact, it is observed in the literature that during COVID-19 pandemic, majority of students showed signs of anxiety (Cao et al., 2020).

The findings obtained from this study have revealed that the concerns of students expressing changes in their concerns about the exam with the pandemic were related mainly to academic motivation, lack of necessary educational support and to the context of changing educational paradigms, while some students were concerned about failing to achieve their goals because of these problems. In central placement exams, students adopt a mindset more concerned about test results rather than the quality of education (FairTest, 2007; Schrag, 2000) and receive additional lectures outside school (Saito, 2006; Ural & Erktin, 2002). It can be stated that as they cannot carry out such activities due to the pandemic, students' anxiety increases. Similarly to the students, parents expressed concerns about the outcomes of the changing educational paradigm and, differently from the students, the health of their children.

Advantages and Disadvantages of Preparing for the Exam during COVID-19 Pandemic

In this study, both the students and parents emphasized having more time to study as an advantage of preparing for the exam during COVID-19 pandemic. In this regard, unlike their parents, students pointed out, apart from the extra time, to the autonomy of existing a structured system and to the advantage of having fewer distracting factors (friends, noise, time lost on the way to school etc.). As a matter of fact, conducted studies show that despite the skeptical positions regarding the efficacy

of distance education (Başaran et al., 2020), it also has some attractive aspects such as autonomy and flexibility provided to the students about the time and place to study (Kurnaz & Serçemeli, 2020; Saltürk & Güngör, 2020). Similarly, in this study, most of the students and parents expressed that lack of sufficient educational support was the leading factor they were concerned about and the main disadvantage in relation to preparing for HEIE during the pandemic; however, they also expressed that because of the autonomy and extra time it provided to the students, this process could be turned into an advantage.

In regard to the advantages of preparing for the exam during the pandemic, students and parents stated their views not only on psychological but also on educational advantages. It has been identified within this context that the views of the students and parents are quite different from each other. While students stated that their rivals' getting demotivated and their extra time to spend more with their families constituted the advantages, parents saw increased control and supervision over their children as an advantage. Time spent at home increased due to the public health policies, which increased the psychological and behavioral control parents had over their children. Accordingly, the parents interpreted this extraordinary period as an advantage in terms of preparation period for the exam. The parents stated that in this way, they could more easily control if their children were studying or not, plan their studies and check peer influence. Saito (2006) also found in his study concerning high-stakes exams in Japan, which has a collectivist structure that parents practice strict control in relation to high-stake exams. In cultures where access to qualified education is limited (e.g., Asian cultures), the importance given to academic achievement is very high. Thus, academic achievement-oriented control practices do not negatively affect young people in Asian cultures (Chao, 2001). When the determining role of parents in students' academic achievement is evaluated (Jeynes, 2012), it can be assumed that such control-oriented practices may have become more functional during COVID-19 pandemic since students have had to fight against uncertainty.

As part of public health policies in Turkey, curfew restriction was imposed for individuals under the age of 20 as of April 4, 2020. Afterward, in line with the course of the pandemic, they were allowed to go out at specific times on certain days on the condition that they respected the rules of social distancing and using masks (Ministry of Interior General Directorate of Provincial Administration, 2020). The findings of this study have shown that both students and parents treat problems caused by lack of activity as disadvantages of preparing for the exam during COVID-19 pandemic. Lockdown and staying in the same environment at home all the time negatively affect the physical and mental health of students. Students, in this regard, expressed that they were longing for the past while parents emphasized the difficulties their children faced in adapting to this period. Similarly, it was found out in a research conducted by Yörüsün (2020) that social isolation policy implemented as a result of COVID-19 caused students to feel like they had to study constantly and to stress out due to always staying at the same environment, and in a study conducted by Karataş (2020) that students were longing for their schools.

Another issue both students and parents discussed as the disadvantage of preparing for the exam during the COVID-19 pandemic is related to educational factors. The findings of this study have shown that there were difficulties in adapting to

online/distance education, that reservations about adopting changing educational paradigms and deprivation of social and academic support on educational terms were interpreted as disadvantages by both the students and parents, and that students' motivation was reduced. It was seen in another study that students and parents had doubts about the efficacy of online/distance education launched because of the pandemic (Başaran et al., 2020).

Conclusion

As can be understood based on the findings obtained from this study, distance and online education, which a vast majority of student population has had to switch to with COVID-19 pandemic, is not only a problem solely limited to the access to technology, but it also reflects basic faults and development inequalities. However, students fight against the increased stress stemming from the transition to distance education and against a limited student life experience. All students - especially those preparing for the exam, which stands as a cornerstone in their lives- would like to feel valued and supported socially and academically in their learning. Developing strong bonds with peers and teachers creates positive relationships that motivate students to do their best. Nonetheless, the safety policies implemented for public health have led to the weakening of such support systems. At this point, it is certain that approaches towards educational technologies with suspicion will not help. However, the way the technology is integrated into the assessment and evaluation processes is a pedagogical issue that can create unexpected problems if it is prescribed only by education bureaucrats.

In conclusion, this study is an early overview of the views of the high school students and their parents about preparing for HEIE during COVID-19 pandemic. Although stress is a natural part of the preparation period for the exam for many students, new stress sources have come into the picture with the pandemic. The anxiety experienced by the students and parents during their efforts to prepare for the exam has become overwhelming. In this regard, it is believed that this study, which addresses student and parent views on preparing for the university admission exam, deeply affecting the lives of millions of students during COVID-19 pandemic, may serve as a source for other studies to discuss a similar subject.

Limitations and Suggestions

The most important constraints of this study are as follows: The data were (i) collected only from the fourth-year students of an Anatolian high school (ii) in relatively early stages of the preparation period for the exam and (iii) the sample examined was small-scaled. In further studies, the data can be collected at different periods of time according to the course of the pandemic and the date of the exam. A larger-scaled sample can be included in the study (e.g., both parents can be participants). A comparative analysis can be carried out between the views of the students who graduated from high school but preparing for the exam once again and the views of the students continuing their high school education. The metaphors students produce about the impacts of the pandemic can be analyzed to examine their experiences further. A study conducted in the United States shows that students who have just started higher education have put their enrollment on hold until they return to face-to-face education to avoid missing student life experiences (Johnson, 2020).

Similarly, as per the data of *Student Selection and Placement Centre* (ÖSYM, 2020b), there were 594,010 students having earned the right to make preferences among universities but did not according to the results of HEIE 2020. Considering this fact, a longitudinal study can be further conducted, and a post-exam review can be carried out on the educational process of the students in accordance with the course of the pandemic and students' rates of registration in the programs can be comparatively analyzed.

Statement of Responsibility

Aylin Saltürk and Ömay Çokluk-Bökeoğlu contributed equally to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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An Evaluation of One Day Science Activities at a Natural History Museum

Doğa Tarihi Müzesinde Bir Günlük Fen Etkinliklerinin Değerlendirilmesi

Ayşegül EVREN-YAPICIOĞLU* **Kalender ARIKAN**** **Aydın AKBULUT*****

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ABSTRACT: This study investigated the evaluation of science activities held over one day at the natural history museum (NHM) in a rural part of Turkey. The purpose of the research was to determine one day science activities in NHM through students' expectations, observations, feelings, learning experiences, and their effect on their academic achievement and explore teachers' views about the process. Middle school students (*n*=125) and their teachers (*n*=8) participated the activities. Qualitative dominant *(QUAL+quan)* parallel convergent design, one of the mixed research methods, was used in the research. Four different data collection tools (achievement test and three semi-structured interview forms) were used. According to the results, the activities had a positive effect on the academic achievement of middle school students. It also helped them gain more profound experiences about the components of nature and develop more positive emotions. Prior to the science activities, the students expected to focus on observations and examinations. They emphasized the activities they conducted to collect and analyze fossils more strongly after the completion of activities. Teachers stated that science activities in the museum increased the active participation and interest of the students compared to the classroom environment and enabled them to provide awareness towards the environment and science.

Keywords: Museum education, middle school students and natural science history museum.

ÖZ: Araştırmada Türkiye'nin kırsal kesiminde bulunan bir doğa tarihi müzesinde bir günlük fen etkinlikleri değerlendirilmiştir. Araştırmanın amacı doğa tarihi müzesindeki bir günlük fen etkinlikleri öncesi ve sonrasında öğrencilerin beklentilerini, gözlemlerini, duygularını, öğrenme deneyimleri ile akademik başarılarına etkisini belirlemek ve sürece eşlik eden öğretmenin görüşlerini keşfetmektir. Ortaokul öğrencileri (*n*=125) ile öğretmenleri (*n*=8) araştırmaya katılmıştır. Karma araştırma yöntemlerinden nitel baskın statülü *(NİT+nic)* yakınsayan paralel desen kullanılmıştır. Dört veri toplama aracı (başarı testi ve üç yarı yapılandırılmış görüşme formu) kullanılmıştır. Elde edilen sonuçlara göre etkinliklerin ortaokul öğrencilerinin akademik başarılarına olumlu etkisi olmuştur. Ayrıca, doğanın bileşenleri hakkında derin deneyimler edinmelerine ve daha olumlu duygular geliştirmelerine katkı sağlamıştır. Müzedeki etkinlikler öncesinde öğrenciler daha çok gözlem ve inceleme odaklı etkinlikler yapacakları beklentisindeyken, etkinlikler sonrasında mikroskopla inceleme, fosil toplama ve analiz etme deneyimlerinden daha sık bahsetmişlerdir. Katılım gösteren öğretmenler ise müzedeki fen etkinliklerinin öğrencilerin sınıf ortamına kıyasla aktif katılımını ve ilgilerini arttırdığı, çevreye ve fene yönelik farkındalık sağladığını belirtmişlerdir.

Anahtar kelimeler: Müze eğitimi, ortaokul öğrencileri ve doğa tarihi müzesi.

* *Corresponding Author*: Dr. Ayşegül Evren-Yapıcıoğlu, Muğla Sıtkı Koçman University, Muğla, Turkey, aevren@mu.edu.tr, https://orcid.org/0000-0003-0528-8528
** Dr. Kalender Arıkan , Hacettepe University, Ankara, Turkey, kalender.a@gmail.com, https://orcid.org/0000-0002-9862-9629
*** Prof. Dr. Aydın Akbulut, Hacettepe University, Ankara, Turkey, akbulut1969@gmail.com, https://orcid.org/0000-0002-7604-4435

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Museums focus on their audiences by designing spaces, programs, and exhibitions that encourage repeat visitors (Anderson et al., 2002). According to the European Group on Museum Statistics (EGMUS, 2020), almost 710 million people visited different types of museums in European countries in 2019. The number of visitors to museums in Turkey was nearly 35 million in the same year (The Ministry of Culture and Tourism, 2020). These numbers show how important museums are for people. Museums showcasing natural history, science, industry, and art are considered tools for visual education as they are devoted to the realization of that educational principle for many years (Klopfer et al., 2005; Melton et al., 1936). Museum education is an applied interdisciplinary field relying on research and methodology derived from psychology, education, sociology, anthropology (Falk & Dierking, 1992; Rennie & McClafferty, 1996), and other areas (Koran & Koran, 1986). As many as 3417 museums in Europe held active special education programs for children in 2019 (EGMUS, 2020). Research on museum education for children in the nineties is extremely limited (Piscitelli & Anderson, 2001), but the number of studies has increased over the last few decades (Laherto, 2013), with out-of-school oriented learning environments gaining importance (Eshach, 2007).

When the educational literature is reviewed, there are many concepts used by researchers related to educational terminology in the literature of such as formal, informal, non-formal, out-of-school, out-of-class, free-choice, coincidental learning (Atmaca, 2012; Falk, 2005; Hofstein & Rosenfeld, 1996; Rogoff et al., 2016; Salmi, 1993; Tuan Soh & Mohd Meerah, 2013). This diversity in conceptualization causes problems in the literature (Hofstein & Rosenfeld, 1996; Rogoff et al., 2016). Most authors have classified the educational environment of museum as either a form of informal learning (Gerber et al., 2001a, 2001b; Shaby et al., 2016) or non-formal science learning (Eshach, 2007).

Studies on museums or museum education over the decades have provided incompatible results that both support its effectiveness and critique its ineffectiveness. Some researchers (Anderson, 1999; Kubota & Olstad, 1991) have stated that the highly stimulating and novel physical and social environments that museums provide are linked to ineffective learning, whereas others have argued that visiting a museum can increase interest, academic achievement, permanence of learning and enhance the enjoyment of science and related activities, which constitute extremely valuable learning outcomes (Ayres & Melear, 1998; Egüz, 2020; Wolins et al., 1992; Yetkiner et al., 2019). The outcomes of museum education persist over time, according to some studies (Dragotto et al., 2006; Falk & Dierking, 1997; Taylor & Neill, 2008), while others have emphasized that these outcomes are temporary (Rennie, 1994; Wolins et al., 1992). Although museum education is not rocket science (Dragotto et al., 2006), it is becoming increasingly complex. All research on museum education can be grouped into three categories: research focusing on the affective and social aspects of visitors' experiences; the behaviors of families or other visitors; and education as training activities (Piscitelli & Anderson, 2001). With the recent digitalization era, virtual reality and mobile museum applications, distance education strategies have come to the fore in museum research (Bontempi & Smith Nash, 2012; Bulut & Uzun, 2021; Kasapoğlu Akyol, 2020; Notario Sánchez, 2020; Taranova, 2020;). Such applications have turned distant places into close proximity to all people and impossibilities into possibilities.

Especially during the COVID 19 Pandemic period, digital applications in museums have gained importance, necessitating the digital participation of the audience in the applications in the museum (Karadeniz, 2020).

Museum education also contributed to enhancing public school students' cognitive learning (Kubota & Olstad, 1991; Suter, 2014). Post-visit activities enabled seventh-year students to construct and reconstruct their knowledge of the concepts and principles of science (Anderson, 1999). Ayres and Melear (1998) studied elementary school (from 8 to 13 years old) students to compare multimedia and hands-on learning in museums. They found that science learning increased when students interacted with multimedia exhibits as opposed to when they interacted with hands-on exhibits. Martin et al. (2016) demonstrated gains in content knowledge recall, self-efficacy, valuation, and aspirations, and links between these gains and positive beliefs about health practices in a museum-based science education program for elementary and secondary school students (aged 10-16 years). On the other hand, Çıldır (2018), determined that the educational activities in the museum did not make any change in the level of knowledge while improving the writing skills of the eighth-grade students. According to Egüz (2020), it had been revealed that teaching practices based on museum education within the scope of the "*Culture and Heritage*" unit were effective in increasing the academic achievement of fifth-grade students, reinforcing the subjects and ensuring learning permanence. Similarly, Türkmen (2018) determined that their visit to the Natural History Museum (NHM), which was structured according to the learning cycle, increased fifth-grade students' academic achievement on fossils and made positive statements about the museum.

When the researches of museum visits, activities and programs and were examined; It emphasized that museums, parks, natural habitats and school gardens are not perceived as out-of-school learning environments by teachers and pre-service teachers (Bostan Sarıoğlan & Küçüközer, 2017) and these areas were out-of-school learning environments where teachers' responsibility is high (Ay et al., 2015). For this reason, teachers' views, knowledge and attitudes towards museum education or visits are decisive in students' museum visits (Mortensen & Smart, 2007). Although teachers know the benefits of taking students on museum trips (Cox-Petersen et al., 2003; Griffin, 2004), blending formal classroom learning with museum education can be difficult (Kisiel, 2003). Tal et al. (2005) stated in their research with 30 teachers (serving at the 4th to 10th-grade levels) that they did not know the reason for their museum visit and described the school trip as a fun activity rather than a well-planned educational experience. Thus, teachers' opinions, knowledge, and attitudes toward museum education or visits determine students' museum visits (Mortensen & Smart, 2007). Solmaz (2015) stated that social studies teachers did not know the concept of museum education and were unaware that its practices had been revealed. According to the author, although all of the teachers participating in the research stated that museum education was essential for the social studies course, it provided permanence in learning, facilitates learning, and provides visual learning, it had been observed that teachers had not taken their students to museum visits recently. Although teachers know the benefits of taking students on field trips to museums (Cox-Petersen et al., 2003; Griffin, 2004), blending formal classroom learning with museum education can be challenging (Kisiel, 2003).

Over the years, the importance of placing museums in curricula and integrating them with informal learning environments is increasing (Shaby et al., 2016). There are many scientific studies for formal educational institutions such as schools. However, it is very difficult to transfer the findings obtained from the studies conducted in the school environment to environments such as museums that are more complex out-of-school environments and have a large number of objects, concrete materials such as exhibitions (Andre et al., 2017). In addition, planning and implementing research in a formal environment can be much easier than in environments outside the school. In informal areas such as museums outside the school, the interaction of students with a large number of objects (exhibitions and collections in the museum) and people (museum staff, teachers, peers and families) complicates the learning process and is restrictive for researchers to carry out such research. However, as Salmi (1993) emphasizes, such environments are effective environments for increasing the interaction between school and society, providing students with opportunities to practice, observe, and increase their motivation.

The NHM use as an educational environment varies based on the subject studied. Mujtaba et al. (2018) described the literature on the role of NHM in increasing learning and supporting science education as complicated. This was expected because the NHMs are diverse, given that they have cultural objects, endemic species, geological structures, fossils, and formations specific to the country, region, city, or district they are situated in. This characteristic of NHM causes variety in studies in the field of science education. Gerber et al. (2001b) noted that as out-of-school activities are difficult to evaluate, they are generally not considered while evaluating students. They also emphasized that informal studies relying on museums are not researcher-friendly. Osborne and Dillon (2007) stated that research in formal settings is more common and how information is acquired in informal environments outside the school remains largely unclear. As can be understood from the literature, studies on museum education have quite different focuses. In addition, many studies also show promising results that museum visits affect students positively and contribute to their learning. However, there are limited studies related to creating a usable instruction program about education in museums, especially the effect of the program on the student. At this point, our study is designed to reveal how an instructional and organized museum environment will contribute to students and whether this instructional practice is suitable for use educational purposes. When the literature on museum education is examined, it is seen that museum education generally consists of pre-museum preparations, museum tours and post-museum evaluation processes (Buyurgan, 2019). It has been determined that the duration of the application at the stage of the museum visit, among the specified categories, varies according to the study group of the research, its variables and the focused context (Çıldır, 2018; Dilli et al., 2018; Egüz, 2020; Martin et al., 2016; Mortensen & Smart, 2007; Türkmen, 2018). In the current research, only the science activities carried out during one day in the museum were evaluated within the scope of the relevant project. The study was conducted in the Ali Demirsoy Natural History Museum (ADNHM), which is one of the out-of-school learning environments, was the site for this study. This museum is unique because of its geographical location. Detailed information on this is presented in the Environment section.

Method

The main problem of the study is that it evaluated the effects of science activities in natural history museums as out-of-school learning environments, on students' achievement, expectations/observations, feelings and learning experiences and to explore teachers' views about the process. The study relied on both quantitative and qualitative data collection and analyses and used a convergent parallel design (QUAL+quan) (Creswell & Plano-Clark, 2015). In the current study, qualitative data were collected for the three sub-problems of the first research question (1a, 1b, 1c) and the second research problem, while for only the fourth sub-problem (1d), quantitative data were collected. As the research problems determined in the current study mainly required qualitative data, more qualitative methods and data collection tools were used. Thus, it is a qualitatively-dominated mixed study. Quantitative data were collected to understand the effect of the activities on the students' academic achievement. As the research problem mostly required qualitative data, more qualitative methods and data collection tools were used. Thus, it was a qualitatively-dominated mixed study.

The purpose of the research was to evaluate one-day science activities in natural history museums (ADNHM) as out-of-school learning environments through students' expectations, observations, feelings, learning experiences, and its effect on their academic achievement, and to explore teachers' views about the process. The sub-problems are given below.

1. What are the expectations and learning experiences of the middle school students about the science activities conducted in the ADNHM?

   a) What are the students' expectations and observations about the object (animate and inanimate entities) in the ADNHM before and after science activities?

   b) What are the students' expectations and learning experiences about the science activities in the museum before and after?

   c) What are the students' feelings about the ADNHM before and after the visit?

   d) Have the science activities in the ADNHM had a quantitative effect on the students' academic achievement?

2. What are the teachers' views about the effect of the science activities on students in the ADNHM?

Study Group

The study group of the current research is comprised of middle school 5^{th}, 6^{th}, 7^{th} and 8^{th} graders (n=125) and eight teachers leading the instructional activities conducted in the museum. Four of the eight teachers leading the instructional activities in the museum had been in an out-of-school environment before. Service year of teachers [Teacher 1 (T1): 4 years, T2: 3 years, T3: 1 year, T4: 2 years, T5: 9 years, T6: 1 year, T7: 5 years, T8: 10 years] who participated the study range from one to 10 years and one of them male and seven of them female. The branches of the teachers participating in the research are science (n=4), social studies (n=2), music (n=1) and physical education and sports (n=1).

Three data collection tools were administered to the middle school students in the study group. One of these tools is a multiple-choice achievement test, and two of them are semi-structured interview forms. The current research data were obtained within the scope of the project titled "*A Scientific excursion in the natural history museum*." 125 middle school students participated in the project training. As the administration of these data collection tools was on a volunteer basis, for the first and second semi-structured interview forms, 100 students were reached, and a total of 92 students were reached for the pre-test and post-test of the achievement test. The data about the participating students' state of being in an out-of-school environment was collected using the first semi-structured interview form. In this regard, it was found that 65 (65%) of the participating 100 students had been in an out-of-school environment. Their responses in relation to the out-of-school trips they had participated in were analyzed by using content analysis to determine the characteristics of the study group. The students' responses were coded as follows: If a student participated in both the visit to the NHM and the trip to Kemaliye, frequency values were separately entered for them; thus the total number of students may vary.

Table 1

Themes and Codes in Relation to the Out-Of-School Environments that the Students Had Visited Before This Study

Theme	Codes	*f*
Museum Visit	Natural History Museum (*f*=35), Ahmet Kutsi Tecer Museum (*f*=8), Ethnography Museum (*f*=2), Topkapı Palace (*f*=2), Toy Museum (*f*=2), Halil Tepe Museum (*f*=1), Ali Kuşcu Science Centre (*f*=1), Atatürk History Museum (*f*=1), Koç Museum (*f*=1)	53
City/Town/Village Trip	Kemaliye (*f*=10), Elazığ (*f*=8), Erzincan (*f*=4), Apçağa Village (*f*=3), Aksaray (*f*=1), Kırkgöz (*f*=1)	27
School Trip	Science High School (*f*=3), University (*f*=1).	4
Others	Picnic (*f*=5), Park (*f*=4), Boat Trip (*f*=3), Theatre (*f*=1), Kite Festival (*f*=1)	14
Total	22 Codes	98

It is seen that the majority of the students have been in out-of-school environments in Table 1. The out-of-school environments the students have been in include museums, cities, towns, school trips, picnics, theatre, kite festivals and boat trips. Most of the students have participated in a trip to a museum (*f*=53). Yet, they have not received any training there.

Data Collection Tools

Four different data collection tools were used: a multiple-choice achievement test and two semi-structured interview forms for students, and a semi-structured interview form for teachers. The achievement test was applied as the pre and post tests to determine the students' academic achievement. The test had 14 multiple-choice questions (4 options) and was sent to 4 faculty members who are experts in the field in order to determine the content validity index. Based on the feedback received from the experts, four questions with negative content validity ratios were discarded. The test

was piloted on 66 people, and its Cronbach Alpha reliability coefficient was .70. The maximum score that students can get from the achievement test is 10.

A semi-structured interview form was prepared to identify the students' expectations and views before the science activities were implemented in the museum. Çalışkan and Çerkez (2012), Egüz and Kesten (2012), and Evren-Yapıcıoğlu et al. (2017) was used in the preparation of semi-structured interview form questions. The first part had a paragraph explaining the study and five questions *(For example: What grade are you in? Have you ever taken a field trip before? Have you ever visited a museum before? etc.)* to gather students' demographic information. The second part had three questions *(For example: What do you hope to see at the NHM? What are your expectations? etc.)* to gather data on the students' expectations. Second semi-structured interview form comprised eight questions *(For example: What did you observe animate and inanimate in the NHM? What did you experience in the NHM?)* to elicit data on the students' experiences after the science activities were complete.

The third semi-structured interview form was developed to gather data on the opinions of teachers on leading the students during the activities and the experiences of the students. The first part had a paragraph explaining the study and five questions to gather demographic information. The second part had five questions (*For example: What did you observe in your students during the application process in the NHM? What are the observations and practices that interest you? Etc.)* to gather data on the teachers' opinions on the students' experiences. All forms were reviewed by three experts who specialized in qualitative research and had experience and student-teacher interviews. Experts did not remove or add questions in the forms. They only made suggestions for better expression of some questions and corrections for spelling errors and structure of the forms. After corrections were made, the interviews forms were administered. While the student interview before the implementation of the science activities in the museum lasted 10 minutes, the interviews lasted between 15-20 minutes. Teacher interviews lasted 10 minutes.

Data Analysis

Analysis of the Qualitative Data: In the analysis of the qualitative data, the inductive content analysis method (Güler et al., 2015) was used, and manual coding was performed. The most important feature of the inductive content analysis method is that themes and categories are derived from the data at hand (Elo & Kyngäs, 2008). A preliminary coding in light of the existing research was not performed. Some stages were followed in the data analysis process. At first, the raw data were transcribed into written text format consisted of sentences and paragraphs to make them ready for the analysis. The transcribed dataset was coded according to the research questions. By bringing similar codes together, sub-themes and themes were generated. A coding scheme was created by organizing sub-themes, themes and codes. The transcript, including the coding scheme and raw data, was sent to two experts specialized in qualitative analysis. The inter-coder reliability was calculated by using the formula proposed by Miles and Huberman (1994). The agreement between the coders was found to be 89%. The last stage was to determine the codes repeated within the sub-themes and themes, and then they were turned into frequency tables and interpreted.

Quantitative Data Analysis: In the analysis of the quantitative data, SPSS 22 program package was used. First, the data were entered into the program. Then assumptions were tested to decide the analysis techniques to be used. It is necessary to test the assumption of normality of the distribution to be able to use parametric statistical test techniques. The following three methods can be used to determine whether the data obtained for a continuous variable are distributed normally: skewness coefficient, mod, median and arithmetic mean. The descriptive characteristics of the quantitative data of the current study are given below.

Table 2

Pre- and Post-Tests' Descriptive Statistics Related to Quantitative Data

Test	Mean	Med	Var.	*SD*	Min	Max	Skew	Kurt
Pre-test	3.90	4	1.97	1.40	1	7	-.16	-.45
Post-test	5.73	6	3.31	1.82	0	10	-.55	.33

As can be seen in Table 2, skewness and Kurtosis coefficients of the pre-test and post-test data are between -1 and +1. Given that the sample size is larger than 30, the distribution of the scores is accepted to be normal. As a result, paired sample t test, one of the parametric tests, was used to investigate the statistical significance between the pre-test and post-test scores.

Also effect size of Cohen's d (Cohen, 1988) is widely preferred for statistical methods (single group t-test, t-test for related samples, t-test for unrelated samples, etc.) in which the difference between the group mean is calculated (Özsoy & Özsoy, 2013). The Cohen d coefficient was used to determine the effect size of the study and it is presented in the quantitative findings section.

Context of the Study

The study was conducted in the Prof. Dr. Ali Demirsoy Natural History Museum at Erzincan University in Kemaliye district, Erzincan. The museum has a total area of 1000 square meters and includes two large halls and conference rooms for 400 and 100 people, respectively, both of which are used for museum education. Natural specimens in the museum are geological materials like minerals, stones, soils, crystals, rocks, and fossil specimens. Another section displays exhibits of microscopic single-cell plants and animals living in the aquatic environment, invertebrates, crustaceans, and mollusks, which are placed in jars filled with alcohol solution. There are also plants in the herbarium, as well as mounted vertebrates from different parts of the country and the surrounding areas of Kemaliye.

Procedures

The current research data were obtained within the scope of the project titled "*A Scientific excursion in the natural history museum.*" The students in the study group of the current research participated in the one-day science activities carried out in the ADNHM in March (n=32), April (n=31), May (n=32) and June (n=30) 2019 in groups. Prior to the instructional practices, a semi-structured interview form and the pre-test were administered to the students. Within the context of informal instructional practices,

a total of six activities were carried out by faculty members specialized in their fields in the ADNHM. The brief contents of six activities are given below.

Table 3

Contents of Science Activities

Name and the Activity	Content of the Activity
1- Travel to 30 million years ago with fossils	Before the activity, 30 fossil specimens within the museum, which are visible in size, were distributed and placed in a 150 m^2 garden. Students were asked to find the fossil specimens they had seen in the museum and they had been given information about by searching in the garden having the same features with their natural environments and take one with them. While searching for the lost fossils, they were asked to think about how the species belonging to 30 million years ago could have survived to the present day, how these creatures living in the sea could be found at the top of the high mountains far from the sea, and to question the fossils by traveling to the past.
2- I discover the plants	The students were allowed to examine more than 1000 plant species within the museum and the plant species grown in the culture medium with a microscope. Moreover, the students were presented with the techniques of keeping these culture plants as museum materials. Then each of the students was given a plant sample cultivated in the culture medium. The students were then informed on how to dry these plants in cartons and keep them intact, and then they were asked to prepare these plants in the same way.
3-Microscopic life in a drop of water	Fixed water samples of the museum collected within the scope of different projects in the previous years were examined under the microscope. In this activity, each student left a drop of water on the slide with a Pasteur pipette from the water samples and then covered it with the coverslip. Participants were asked to observe the single-celled creatures in the water by putting this preparation under a microscope, first finding the image from the smallest magnifying lens, and then moving to other large lenses for clarity. Each living thing they saw was examined together with their instructors. Discussions were conducted in a dynamic manner about which group it belongs to, its features and its importance in the ecosystem.
4- I am touching insects	Insect samples in the exhibition and storage cabinets in the museum were distributed to the students. Each student was allowed to observe the samples with the help of a magnifying glass and a microscope. After the concerned expert gave the students the necessary information on how these insects are caught, a sweep net with an insect catching bucket was distributed to each student. The bugs caught with the buckets were rereleased without taking them. Later, one of the insect samples found in alcohol in the museum was placed in petri dishes and distributed to the students with forceps and needles. Each student was asked to examine it under a microscope. During the examinations, the instructors gave detailed information to the students about the insects' eyes, antennas, mouth structures, wings, legs, and abdomen parts.
	The activity aimed to teach the relations of living groups in the ecosystem with each other and what kind of food web they were in, through interactive play. Each player took a card from a middle pile

5. Biological Diversity	and raised it so that everyone could see the name of the organism on the card. The person who had drawn the tree card started the game by picking up the ball of twine and tossing it to someone else in the circle. The person who caught the ball tried to explain how the organism on their card interacted with the tree. Anyone in the group could join to help with this clarification. Next, the person who caught the ball grabbed the rope and tossed the ball to a third person. The third person explained how the organism on his card interacted with the second person's organism. If the player got stuck, everyone in the game could guess. The game continued until it is everyone had a chance to catch the twine. The string was now complex and tangled and everyone in the group was connected. Players could also discuss and exchange ideas about how their own organisms related to others that had appeared earlier in the game.
6. Traces from the Nature History Museum	The activity tried to understand which of the phenomena students created in their own world regarding the museum came to the fore. During the activities held throughout the day, they had the opportunity to meet many living species from exhibition materials to the world of microscopes to mammals and gained experience about many living and non-living things that they had not seen, touched or felt before. Regarding the subject, they were given drawing paper, an eraser and a pencil, and they were asked to draw and explain what the museum meant to them.

Ethical Procedures

The current research data was obtained within the scope of the project titled "A Scientific excursion in the natural history museum." Ethics committee application and permission for the research was received from Hacettepe University on October 16, 2018 (numbered 35853172-900). Since the study group of the research was students under the age of 18, a parent permission form was used and obtained all the students who are participated in science activities in ADNHM. Students' responses to data collection tools for research are completely voluntary.

Results

Qualitative Findings About the Students

Two semi-structured interviews were conducted before and after the science activities were held at the museum. The students expressed that they expected to see some specimens in the interview conducted before the activities and preferred to talk about what they observed during the science activities in the interview that followed. The codes derived from these responses of the students are explained under the themes of expectations and observational experience of animate and inanimate entities and are presented in Table 4.

Table 4

Students' Expectations and Observations of Animate and İnanimate Entities

Themes	Pre-activities Codes (Expected)	The Types of Codes	f_{pre}	Post-activities Codes (Observed)	The Types of Codes	f_{post}
Geological Structures and Fossils	Fossils (*f*=28), Dinosaur Skeleton (*f*=9), Bone (*f*=5), Stone (*f*=10)	4	53	Fossils (*f*=59), Stones (*f*=16), Rocks (*f*=8), Lichens (*f*=5), Core of the Earth (*f*=3), Minerals (*f*=1), Magma (*f*=1), Natural Disaster (*f*=1).	8	94
Vertebrates	Animals (*f*=31), Snake (*f*=10), Fish (*f*=3), Deer (*f*=2), Rain Beetle (*f*=2), Bird (*f*=1), Turtle (*f*=1), Gorilla (*f*=1), Mammoth (*f*=1)	9	52	Animals (*f*=23), Snake (*f*=16), Wolf (*f*=7), Fish (*f*=7), Leopard (*f*=5), Fox (*f*=5), Grizzly Bear (*f*=4), Bird (*f*=4), Goat (*f*=2), Frog (*f*=2), Blowfish (*f*=2), Mouse (*f*=1), Sea Otter (*f*=1), Bee Eater (*f*=1), Goose (*f*=1), Wildcat (*f*=1), Yeanling (*f*=1), Owl (*f*=1), Squirrel (*f*=1), Eel (*f*=1), Anatolian Leopard (*f*=1), Deer (*f*=1), Dinosaur (*f*=1).	23	89
Invertebrates	Insect (*f*=18), Butterfly (*f*=5), Scorpion (*f*=3), Spider (*f*=1), Grasshopper (*f*=1), Caterpillar (*f*=1)	6	29	Insect (*f*=65), Butterfly (*f*=9), Scorpion (*f*=8), Mosquito (*f*=6), Cockroach (*f*=5), Spider (*f*=5), Fly (*f*=4), Caterpillar (*f*=4), Earthworm (*f*=3), Bee (*f*=3), Sea Shell (*f*=3), Starfish (*f*=3), Grasshopper (*f*=3), Coral (*f*=2), Lobster (*f*=2), Mussel (*f*=2), Crustaceans (*f*=1), Centipede (*f*=1), Harvest Fly (*f*=1)	19	130
Plants	Plants (*f*=8)	1	8	Flowers (*f*=22), Plants (*f*=11), Tree (*f*=2), Tree Root (*f*=1), Flower Liquid (*f*=1), Flower Leaf (*f*=1), Pollen (*f*=1), Reverse Tulip (*f*=1)	8	40
Microscopic Living Things	Microscopic Living Things (*f*=7)	1	7	Microscopic Living Things (*f*=16), Euglena (*f*=6), Microorganisms (*f*=1), Alga (*f*=1), Microbe (*f*=1), Protozoa (*f*=1)	6	26

Historical Ruins	Ruin (*f*=6), Archaeology History (*f*=1), Historical Artefact (*f*=1), Historical Natural Artefact (*f*=1), Historical Weapon (*f*=1)	5	10	-	-	-
Scientists	-	-	-	Prof. Dr. Ali Demirsoy (*f*=3), Scientist (*f*=2), People from University (*f*=1), Prof. Dr. Aydın Akbulut (*f*=1)	4	7
Others	Poster (*f*=1), Device (*f*=1), Robot (*f*=1), Animal Drawing (*f*=1)	4	4	Larva (*f*=6), Animal Skin (*f*=5), Skeleton (*f*=1), Goat Horn (*f*=1), Blood (*f*=1), Herbarium (*f*=1), Bark (*f*=1)	7	16
Mushrooms	Mushroom (*f*=1)	1	1	Mushroom (*f*=5)	1	5
Total		31	164		76	407

As can be seen in Table 4, before and after the activities were conducted, the students had similar responses and more codes were derived from them. Only historical ruins in the scientist's pre- and post-activities did not have any code. A tangible increase was seen in the type and number of codes from the pre- (Types of codes: 31, *f*=164) to post-test (Types of codes: 76; *f*=407) stages. Before the activities were conducted, the students expected to see geological structures and fossils (*f*=53), vertebrates (*f*=52), and invertebrates (*f*=29). After the activities were conducted, they stated that they had observed invertebrates (*f*=130), geological structures and fossils (*f*=94), and vertebrates (*f*=89). The students described their expectations and experiences of the science activities in the ADNHM. Their responses are presented under four different sub-themes (observation and analysis, gains, others, and undescribed) in Table 5.

Table 5

Students' Expectations and Learning Experiences of the Science Activities

Sub-themes	Codes	f_{pre}	f_{post}
Observation and Analysis	Observing and analyzing different specimens	31	16
	Analyzing with a microscope	6	23
	Collecting and analyzing fossils	2	20
	Collecting and analyzing insects	-	8
Gains	Learning different/new/unknown things	17	11
	Getting to know and learn about living things in nature	5	10

	Raising awareness of living things in nature	1	4
	Learning how to use a microscope	-	8
	Raising awareness of the formation of the earth	-	5
	Learning how herbariums and museums are established	-	2
Others	Planting trees	2	-
Undescribed	Now knowing what to do	5	-
Total	12 Codes	69	107

According to the pre-test data, some students expected to engage in seven different instructional practices, whereas some did not know what to do (f=5). However, a significant increase occurred in the type and number of the codes related to students' experiences compared to expectations in the post-test. Whereas the students expected to observe and analyze different specimens before activities, they talked about observations and experiences like conducting analyses with a microscope and collecting and analyzing fossils after activities. It is remarkable that microscope-related codes were distributed to two different codes and themes. Student statements are presented in Table 6 under different themes based on the emotions they felt before and after the activities were conducted.

Table 6

Emotions Felt by the Students Before and After the Activities Were Conducted

Theme: Emotions	$f_{(Pre-)}$	$f_{(Post-)}$
Happiness	27	13
Curiosity	13	4
Excitement	12	3
Beautiful	12	24
Nice	4	4
Enjoyable	2	21
Wonderful	1	1
Gratitude	-	5
Love	-	4
Interest	-	4
Stress reduction	-	1
Neutral	-	1
Bored	-	1
Total	71	86

Students used 7 and 13 codes to express their feelings before and after the activities were conducted, respectively, as seen in Table 6. The number of repeated

codes increased. Students defined themselves as happy, curious, and excited about the activities at first. However, after the activities, the number of statements around satisfaction decreased, while that around enjoyment, beauty, and similar themes increased. They also expressed gratitude to the experts who helped them while conducting the activities.

Quantitative Findings About The Students

Paired samples t-test was conducted on the data from the achievement test and the findings are presented in Table 7. There is a statistically significant difference between the achievement test mean scores from the pre- and post-tests' phases [$t_{(91)}$=9.9, p<.05] as seen in Table 7. The differences between the mean scores reached 31.93%. These results show that the activities conducted at the museum had positive effects on the students' academic achievement.

Table 7

Paired Samples T-Test Conducted on the Pre- and Post-Tests' Scores Obtained from the Achievement Test

	N	Mean	*SS*	*SD*	*t*	*p*
Pre-test	92	3.90	1.40	91	-9.9	.00
Post-test	92	5.73	1.82			

Cohen d coefficient was calculated as .69 in the study. Since the Cohen d coefficient was between .2 and .8 (Cohen, 1988) as the effect size of the study, it was determined that it had a moderate effect.

Qualitative Findings About the Teachers

Through a semi-structured interview, teachers' opinions were elicited. The teachers were asked to record their observations of the students they accompanied. Eight codes were formed and are presented under two themes in Table 8.

Table 8

The Teachers' Views about the Effect of the Science Activities on the Students in the ADNHM

Theme 1: The effect of the Science Activities on Students Conducted at the Museum	
Codes	Quotations
Permanent Learning	T5: I think that the students were more active than they are in class and they achieved.
Active Participation	T8: In my opinion, the students were more active here and thus more permanent learning was accomplished.
Interest in Science	T7: The students feeling like scientists were quite impressive.
Concrete Life Experiences	T3: Students were able to attain concrete experiences.
Skill to Access	T8: They arrived at the information they needed without being

Information	perplexed by the large amount of theoretical information presented to them.
Environmental Sensitivity	T1: I think they were able to develop a different but more sensitive perception of the environment.
Theme 2: Students' Experiences during the instructional practice	
Observation and Analysis	T5: Students were provided opportunities that they could not otherwise access in Kemaliye and thus, they conducted analyses.
Using a Microscope	T6: Students were interested in the details they had seen for the first time. They were able to see through the microscope for the first time and gained knowledge on how to use it.
Total: 8 Codes, 2 Themes	

Note: T=Teacher

When Table 8 examined, the teachers accompanying the students thought that the science activities conducted at the museum fostered active student participation, enhanced their interest in science, helped them develop the skills they needed in order to have access to information, and improved their sensitivity toward the environment. They also stated that through the science activities conducted at the museum, the students learned to use a microscope and were engaged in observation and analysis.

Discussion and Conclusion

The purpose of the current study was to evaluate science activities in ADNHM as out-of-school learning environments through students' expectations, observations, feelings, learning experiences and its effect on their academic achievement, and to explore teachers' views about the process. Since the conceptual expressions of the students about the names of animate and inanimate entities in the museum collection have increased approximately two and a half times (The type of codes; f_{pre}=31, f_{post}=76; number of repeated codes; f_{pre}=164 f_{post}=407), the science activities conducted in the museum were found to have important contributions to the conceptual development of the students. When students presented the general name of the class or phylum of living things, such as plants, animals, insects etc., before the activities, they expressed the specific name of the species, genus, or ordo rather than upper taxonomic category names after activities as shown in Table 4. The quantitative data obtained for the fourth sub-problem of the study revealed that the science activities conducted have positive effects on the learning of the students [$t_{(91)}$=-9.9, $p<.05$]. The Science activities in the NHM resulted in moderate effect in practice (Cohen d=.69). As it is known, conceptual development is one of the first steps in the accomplishment of learning. It was expected because of the characteristics of an informal learning environment (Callanan et al., 2011; Marsick & Volpe, 1999). The training in museums that allow using real and concrete materials help children to learn about a subject and perceive abstract concepts more easily depending on their cognitive development (Dilli et al., 2018). Similarly, Türkmen et al. (2016) are of the opinion that trips to informal learning environments such as NHM will contribute to students' classification of living things. The activities conducted in out-of-school environments like the museum in this study had a positive contribution to the students' conceptual development (Livingstone, 2006) and learning (Anderson et al., 2003; Gerber, et al., 2001a). The teachers participating in the current

study are also of the opinion that the instructional activities conducted in the ADNHM *"helped students be more active than they are in the class and achieve more permanent learning."*

Before the activities were conducted, students expected to see geological structures and fossils rather than other specimens, and they talked more about their observations of invertebrates, geological structures, fossils, and vertebrates after the activities were conducted. The students expected to see more of the geological structures and fossils before the application because the activities in the current study would be made in a NHM and that students thought that they would see more inanimate components of nature such as fossils, stones and rocks. After the science activities in the museum, the students more frequently mentioned their observations about invertebrates using more code types. This might be because of the fact that these creatures were included more in the museum concept and that they have a much higher number of species in the world (Turkey Ministry of Forestry and Water Management, 2013) of living things. Another remarkable finding is that the students expressed expectations to see the objects normally exhibited in ethnography museums, such as historical ruins and historical weapons in the ADNHM. This might be because some of the participating students had visited ethnography museums before. In the theme of scientists emerging after completing the science activities, the students mentioned the names of the scientists involved in the practices, and thus, they observed. Involvement of faculty members from universities in such studies allowed the students to observe these scientists.

The results show that the students engaged in a different situation in the museum, which had gone beyond their expectations. The students' expectations and experiences of the science activities conducted in the ADNHM were collected under three sub-themes. Before the activities were conducted, they mostly thought that they would observe or analyze something in the museum. According to Salmi (1993), students learn to observe and gain new experiences in such informal environments. The sub-themes and codes reached provide information about student experiences during the activities NHM, one of the out-of-school learning environments, and deepen the research. In the current study, while the students mentioned that they would perform actions such as observing and analysing living / non-living things before the application of the science activities, they mentioned that they carried out activities such as using a microscope and collecting and analysing fossils after the application of the instructional practices. According to this result, it can be said that the activities of "*traveling to 30 million years ago with fossils*" and "*microscopic life in a drop of water*" that students carried out during the informal science activities were interesting for them. In addition, the species belonging to the world of microscopic living things and fossils dating back to millions of years ago are living and non-living things drawing the students' interest. In their study, Green and Smith (2005) argued that small-sized things aroused great interest for primary school students and that the students' introduction to the microscope through the applications conducted by a primary school in cooperation with a university increased their interest in science and supported their success in science. As a result of the observations of the teachers who accompanied the students during the instructional practices, the codes related to the use of microscope and observation-analysis emerged. In addition, the fact that the variety and number of codes in the sub-theme of observing

and analyzing is high can be interpreted as the science activities carried out in the museum contribute to the observation, classifications, predication skills, which are scientific process skills. When the studies in the literature are examined, it is stated that museum education for different participant groups than the current research improves the scientific process skills of the students (Bodur & Yıldırım, 2018; Öztürk Samur et al., 2015). In addition, similar results were reached in studies in which more than one area (one of them was museum) and different participant group was used for out-of-school learning environments (Uludağ, 2017).

Students' emotions pertaining to the activities conducted were the most interesting outcomes. They expected to engage in an out-of-school activity in a museum for which they were not responsible as in school. However, the activities in the museum comprised an instructed program. It was different from what the students engaged with at school and it took place in an environment outside of school. Thus, they were happy, curious, and excited about the activities before visiting the museum. These feelings gave place to feelings of enjoyment and appreciation for beauty after the activities were conducted. Appreciation of beauty and enjoyment are more objective and tangible. Anderson and Lucas (1997) noted that curiosity is a stimulus that helps one explore, manipulate, and interact with the environment and is generated by the individual's feelings of perceived novelty. The results show that the activities satisfied students' curiosity after the program was conducted. McManus (1987) suggested that a part of the reason for visiting a public education facility is the anticipation of enjoyable social interaction. Visits to museums are enjoyable social events (Anderson, 1999). This is partly because visitors expect to enjoy the social context (Falk & Dierking, 1992, 1997). Out-of-school environments enhance student interest in topics like biology (Uitto et al., 2006) and effectively increase their motivation (Shoshani & Eldor, 2016). Whereas only two students stated that the activities were enjoyable before visiting the museum, the number increased to 21 after the activities were conducted. The reason for the increase was that activities in the museum, as shown in Table 2, involved social interactions among the students and between students and instructors. Low happiness and excitement on the part of students in the beginning may explain that they did not have any expectations pertaining to the museum experience. They expected to visit the museum and walk around. In addition to this, students were tired due to participating in activities all day. This may be another reason for the decreased happiness and excitement after the activities.

Teachers were also of the view that activities in the museum "*helped students become more active than they were in class and to achieve more permanent learning*." Thus, it can be argued that such practices can have positive effects on students' learning outcomes. Sontay et al. (2016) concluded that science teaching carried out in out-of-school environments can make students' learning more permanent and can provide students with effective and enjoyable means of learning. Some qualitative codes derived from the teachers' opinions are explained above in relation to student learning outcomes. The teachers thought that the instructional practices conducted at the museum fostered active student participation, enhanced their interest in science, helped them develop the learning skills they needed in order to gain access to information, improved their sensitivity toward the environment, and helped them accomplish more permanent learning. They stated that in informal instructional practices conducted at the museum,

students were engaged in observation and analysis with the use of a microscope. Storksdieck (2001) examined the museum experiences of teachers and students and stated that teachers had a different experience of the educational trip to the museum, as they came with far more knowledge and awareness than their students.

Implications

Activities conducted in museums for middle school students seem to be effective in enhancing their conceptual development and learning. These activities can be more expansive by including different student groups, such as high school and university students, to improve their knowledge of the classification of living and non-living things and different branches of science such as taxonomy and gain experience by making observations. Aside from museums, university laboratories, campuses, and workshops that can increase students' interaction with scientists can be used to conduct such activities.

Museums globally serve all the people, but they also carry the special characteristics of the country, region, or district that they are set in because of the things they exhibit. Student observations and experiences in NHM in different regions and districts can be examined in this respect. It motivated the students to participate in instructional activities and discover different objects and people outside school. Education in a museum is not very difficult in terms of access to space and resources. However, the problem is the lack of qualified instructors and teachers. Different experts from universities helped conduct activities as instructors in this study. Most museums in Turkey do not have special education programs and instructors. Museums with special education programs in other countries in Europe are also limited in number. In this respect, we suggest that museums offer an effective learning environment for students and other people.

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Statement of Responsibility

The authors contributed equally to the related research. Therefore, each author is equally responsible.

Conflicts of Interest

This research has no financial, commercial, legal or professional relationship with other organizations or those working with them. There is no conflict of interest that would affect the research.

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School Climate and Self-Efficacy as Predictor of Job Satisfaction

İş Doyumunun Yordayıcısı Olarak Okul İklimi ve Öz-Yeterlik

Yusuf TÜRKER* **Ümit KAHRAMAN****

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ABSTRACT: In this research, the direct effect of school climate on teacher job satisfaction and the indirect effect of school climate on job satisfaction through self-efficacy were investigated. International Teaching and Learning Survey-2018 data collected by the Organization for Economic Co-operation and Development from Turkish teachers were used in the study. The research data were obtained from the responses of the participants to the Teacher Self-Efficacy, Job Satisfaction and School Climate scales in the International Teaching and Learning Research Teacher Questionnaire. Although a total of 15498 teachers working in primary school, lower secondary school and upper secondary school participated in the research, participants with missing data were excluded from the analysis. Within the scope of the research, data obtained from 12111 teachers were used. Following the testing of the constructed model with the structural equation model, the following results were obtained: Teachers' self-efficacy directly affects job satisfaction. The perceived disciplinary dimension of the school climate directly and negatively affects job satisfaction. The other two dimensions of the school climate, teacher-student relations and the dimensions of participation among stakeholders, affect job satisfaction directly and positively. All dimensions of the school climate indirectly affect job satisfaction through self-efficacy.

Keywords: School climate, self-efficacy, job satisfaction, TALIS 2018.

ÖZ: Bu çalışmada, algılanan okul ikliminin öğretmen iş doyumunu nasıl etkilediği ve öz yeterliliğin okul ikliminin iş doyumu üzerindeki etkisinde nasıl aracılık ettiği araştırılmıştır. Araştırmada Ekonomik İş birliği ve Kalkınma Örgütü tarafından Türk öğretmenlerinden toplanan 2018 Uluslararası Öğretme ve Öğrenme Araştırması verileri kullanılmıştır. Araştırma verileri Uluslararası Öğretme ve Öğrenme Araştırması Öğretmen Anketi'nde yer alan Öğretmen Öz-yeterlik, İş Doyumu ve Okul İklimi ölçeklerine katılımcıların verdikleri yanıtlardan elde edilmiştir. Araştırmaya ilkokul, ortaokul ve lisede görev yapmakta olan toplamda 15498 öğretmen katılmasına rağmen eksik veri içeren katılımcılar analiz dışı bırakılmıştır. Araştırma kapsamında 12111 öğretmenden elde edilen veriler kullanılmıştır. Kurgulanan modelin yapısal eşitlik modeli ile test edilmesinin ardından şu sonuçlara ulaşılmıştır: Öğretmenlerin öz yeterlilikleri iş doyumunu doğrudan etkilemektedir. Okul ikliminin disiplin boyutu iş doyumunu doğrudan ve olumsuz etkilemektedir. Okul ikliminin diğer iki boyutu olan öğretmen öğrenci ilişkileri ve paydaşlar arasında katılım boyutları iş doyumunu doğrudan ve pozitif yönde etkilemektedir. Okul ikliminin bütün boyutları öz yeterlilik üzerinden iş doyumunu dolaylı olarak etkilemektedir.

Anahtar kelimeler: Okul iklimi, özyeterlik, iş doyumu, TALIS 2018.

* Dr., Ministry of National Education, Antalya, Turkiye, yusuf.turker@gmail.com, https://orcid.org/0000-0003-4276-6648
** *Corresponding Author*: Asst. Prof. Dr., Bilecik Şeyh Edebali University, Bilecik, Turkiye, drumitkahraman@gmail.com, https://orcid.org/0000-0002-4547-6753

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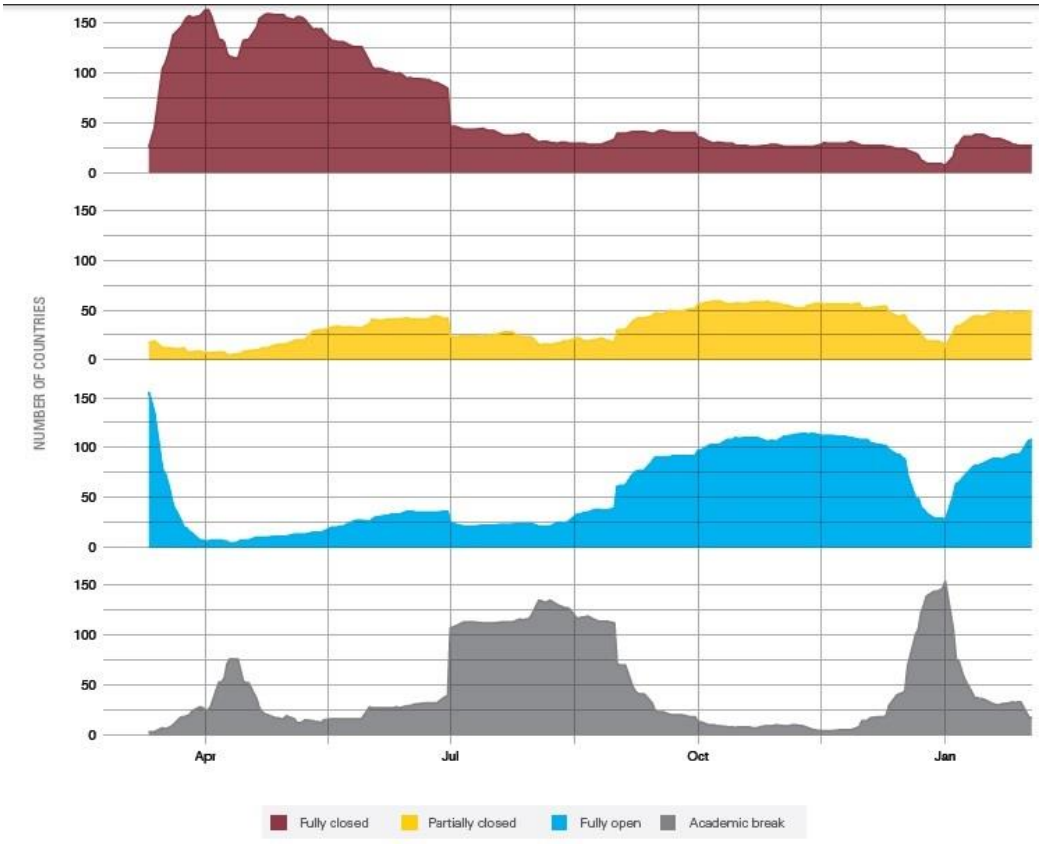
With the discussions of the 4th Industrial Revolution, concepts related to high technology such as the internet of things, artificial intelligence and autonomous systems started to take place on our agenda. The idea that these systems will replace the people in many jobs is a source of fear for some, whereas it is a future they are eagerly waiting for others. The debates also brought about many future predictions on education systems, schools, and the teaching profession. In some of these predictions, it has been claimed that schools will not exist and that teachers will be replaced by various software (Shahroom & Hussin, 2018; Tanrıöğen, 2018). The future world will perhaps justify these views, or it will be proven wrong; perhaps, there will be other consequences that no one has ever predicted. However, it can be suggested that there is no such formation to replace schools and teachers in today's conditions. What happened during COVID-19 pandemic period showed us this once again. The closure of schools around the world due to COVID-19 demonstrated how difficult it is to supply educational necessities of communities without schools and teachers.

Figure 1

Time-Series of School Closure Status from March 2020 to February 2021



Reference: UNESCO Global monitoring of school closures caused by COVID-19 (http://covid19.uis.unesco.org/global-monitoring-school-closures-covid19/)

After the rapid closure observed in the first months of COVID-19, the priority of many countries to keep schools open once again brought up the importance of schools in education systems. When Figure 1 is examined, it is seen that the full closures, which were intensely experienced at the beginning of the pandemic, are gradually decreasing and countries are heading towards full opening (United Nations Educational, Scientific

and Cultural Organization [UNESCO], 2021a). According to UNESCO data, schools are fully open in 116 countries as of May 31, 2021 (UNESCO, 2021b). Considering that there was an economic recession in the world according to International Monetary Fund data in the same period, it can be said that keeping schools open is more important than maintaining economic activities for some countries (International Monetary Fund [IMF], 2021). In summary, it can be said that schools providing mass education and teachers who provide this education are at an indispensable point in meeting the educational needs of today's societies.

Today the outputs come to the fore when it comes to the effectiveness of education systems. In other words, students' learning is concentrated on. For example, Turkey's results obtained from the Programme for International Student Assessment (PISA) test held by Organization for Economic Co-operation and Development (OECD) are issues discussed by many people. However, as professionals of the education system, teachers' perceptions of the general education system and their professions can be useful for improving effectiveness of education because the improvement of educational outcomes depends on the teacher factor, which is one of the basic inputs of education. In this context, how teachers perceive the education system and the school can be extremely useful in terms of self-evaluation of themselves, determining problems, developing solutions, and improving human resources.

While OECD focuses on the student dimension of education systems with PISA exam, Teaching and Learning International Survey (TALIS) focuses on school administrators and teachers. TALIS aims to examine the effects of educational policies implemented by governments in schools in terms of teachers and school principals. In the TALIS research, which was implemented for the third time in 2018 by the OECD participated by 48 countries and economies, the participants were asked various questions about teachers' professional experience and qualifications, professional development, teaching practices, job satisfaction, perceptions of cultural diversity, school climate, and their own competence levels. Although OECD shares its reports containing country-based and inter-country comparisons with the international community, these reports do not include in-depth analysis. The organization shares the data it obtains and makes it available to researchers who ask for access. TALIS (performed by the OECD in 2018) data was used in this article. The data used in the study are obtained from teachers in Turkey. The research focuses on the variables of school climate, self-efficacy and job satisfaction. In this context, our problem is whether self-efficacy has a mediating role in the effect of school climate on job satisfaction.

Theoretical Framework

School Climate

Although the first researches on school climate started in the 1950s (Cohen et al., 2009), it cannot be said that the concept has an agreed definition yet (Malinen & Savolainen, 2016). According to many researchers, the school climate occurs of common values, faiths and opinions. These common values, faiths, and opinions shape school stakeholders' interactions and determine the characteristics of behavior and norms (Emmons et al., 1996; Esposito, 1999; Mitchell et al., 2010). There are also those who try to explain the school climate in more abstract terms. The school climate is the

core and spirit that shapes the mood of stakeholders. This mood may cause students, teachers and administrators to be willing or unwilling to come to school (Freiberg & Stein, 1999).

The school climate shapes the interactions of all school stakeholders, namely students, teachers, administrators, other staff of the school and parents. This shaping creates the school's goals, norms and values. The school realizes its educational and social functions through these created goals, values and norms. The fact that the school has social functions, as well as educational functions, reveals that the school is not just an educational institution. According to Cohen et al. (2009), a school is a place where students experience meaningful social relationships and being able to act independently. With this aspect, school is not only a place where students develop cognitively but also an environment where they develop emotionally and behaviorally. Although there are many definitions of school climate, we chose a teacher-centered definition. Johnson et al. (2007) define the school climate in teacher-oriented perspective. School climate is a psychosocial environment where teachers instruct and teach. The school climate is analyzed from this perspective in the study.

Researches appear that school climate is related to many variables associated to education. While positive perceptions about school climate reduce the stress, wear and burnout of teachers; It positively affects teachers' perceptions of self-efficacy, job satisfaction and their relations with students (Collie et al., 2012; Lee & Louis, 2019; Lee et al., 1991; Van Beurden et al., 2017). The positive school climate also increases teachers' possibility of remaining in the profession (Ingersoll, 2001). The school climate is not only effective on teacher outcomes. While positive school climate perception increases students' academic achievement and learning will, it also decreases aggression and the possibility of taking a break from school (Cohen et al., 2009; Thapa et al., 2013).

Self-Efficacy

According to Bandura (1997), although individuals have control over their behavior, behavior and consciousness are affected by environmental factors. According to him, the perception of self-efficacy created by consciousness shapes the goals and actions of the person on the one hand and is also affected by environmental conditions. Self-efficacy expresses the belief in designing the actions that lead to the goal with one aspect and realizing them in the other. These beliefs about self-efficacy are not static personality traits, and they can be learned. These beliefs can change according to how the person perceives their environment (Bandura, 1997).

When self-efficacy is evaluated from the teacher's perspective, it can be defined as the teacher's belief to be effective on student outcomes (Tschannen-Moran et al., 1998). According to Dellinger et al. (2008), self-efficacy is the teachers' personal faiths that he/she can perform the defined teaching missions under certain environmental conditions. Teachers' perception of self-efficacy cannot be considered only as teachers' personal beliefs about themselves. Teachers' self-efficacy faiths can affect children's behavior, learning and self-efficacy. Having a powerful sensation of self-efficacy, teacher can increase student participation by making teaching activities more meaningful for everyone. According to Gibson and Dembo (1984), teachers with strong

self-efficacy have confidence that they can influence and teach even the most problematic students.

Studies reveal that teachers' self-efficacy is effective on students' output. Hattie (2003) observed that teacher self-efficacy affects students' learning more than teacher effectiveness. Many researches have revealed that teacher self-efficacy positively affects students' cognitive achievement (Muijs & Rejnolds, 2001; Ross, 1998). Teachers who have strong self efficacy may be more innovative and careful about students' autonomy (Cousins & Walker, 1995). These teachers are willing to get more liability for children who need special education (Allinder, 1994). Teachers with strong self-efficacy perform better in classroom management (Chacon, 2005) and motivate students to learn (Podell & Soodak, 1993). While students' performance can be affected by teachers' self-efficacy, student performance can also affect teachers' perception of self-efficacy. Raudenbush et al. (1992) found that teachers have strong self-efficacy perception in schools where there are successful students.

Teacher self-efficacy is associated with many organizational variables—a negative correlation between teachers' self-efficacy with stress and burnout found by Betoret (2009). Caprara et al. (2003, 2006) showed that self-efficacy is positively associated with job satisfaction. There is a correlation between school climate and self-efficacy. Teachers' self-efficacy perceptions can rise when school climate is positive (Ciani et al., 2008). Additionally, high teacher self-efficacy decreases tendency of leave the profession (Soodak & Podell, 1993).

Self-efficacy perception is not a feature that becomes stable once it is acquired. Environmental conditions can affect self-efficacy perception (Bandura, 2012). Teachers' perception of self-efficacy is relative and may change according to environmental conditions (Gibson & Dembo, 1984). Hoy and Woolfolk (1993) also support the view that self-efficacy perception is relative and argue that it will be affected by the school climate. Findings from previous studies also reveal that self-efficacy perception is not a fixed variable. While the perception of self-efficacy is affected by other variables, on the one hand, it may affect different variables on the other hand. For this respect, we assume that teacher self-efficacy can be affected by school climate and can influence job satisfaction. With another expression, self-efficacy can play a mediator role in relation to school climate with job satisfaction.

Job Satisfaction

Job satisfaction is a sum of people's positive or negative feelings concerning their professions (Locke, 1976). On the other hand, teacher job satisfaction can be defined as the sense of satisfaction that people have with the teaching profession (Ainley & Carstens, 2018). According to Skaalvik and Skaalvik (2015), teacher job satisfaction is the sum of positive and negative evaluations of teachers about their profession.

Researches show that teacher job satisfaction is correlated with many organizational and educational variables. While the increase in teacher job satisfaction increases performance (Judge et al., 2001), perception of self-efficacy (Caprara et al., 2003) and commitment (Reyes & Shin, 1995); It has been detected to reduce burnout (Skaalvik & Skaalvik, 2010) and stress (Klassen et al., 2010). In addition, it has been found that job satisfaction is positively interrelated with enthusiasm (Chen, 2007),

teacher-student relations (Dinham, 1995), and relationships with parents (Skaalvik & Skaalvik, 2011). Some researchers argue that job satisfaction is a strong indicator of teachers' tendency to stay or quit the profession (McConnell, 2017; Schaufeli & Salanova, 2007).

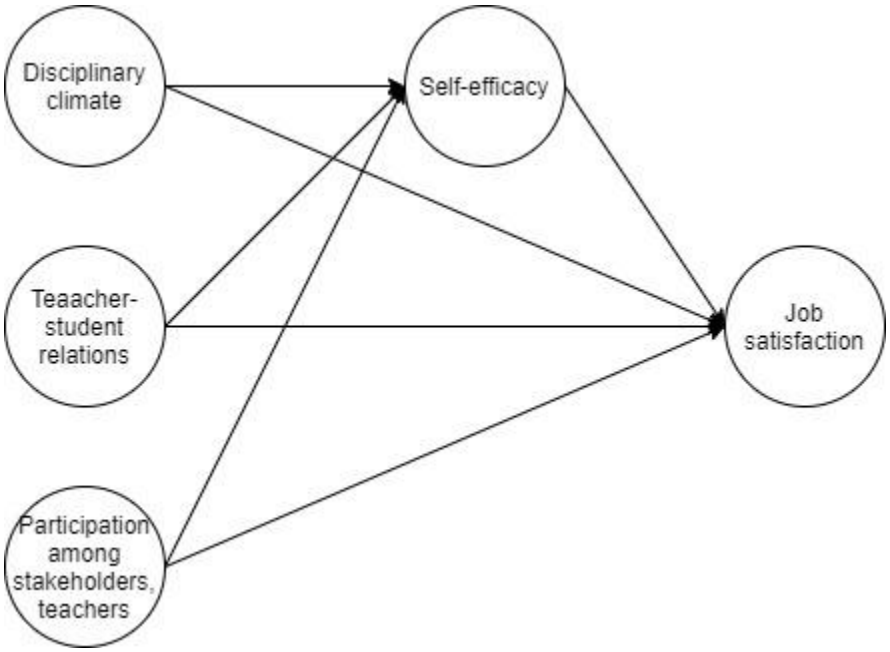
Job satisfaction means the level of contentment teachers achieve from their profession after evaluating positive or negative professional experiences as a whole. With this aspect, job satisfaction can be evaluated as a result affected by different variables. It has been observed in other studies that the variables of school climate and self-efficacy considered in the research are effective on job satisfaction. Having positive views on school climate positively affects teachers' job satisfaction perceptions (Collie et al., 2012; Lee et al., 1991; Veldman et al., 2013). Similarly, researchers have manifested a positive relationship between self-efficacy and job satisfaction (Caprara et al., 2003, 2006; Skaalvik & Skaalvik, 2009, 2014). The former research results have led us to think that school climate and self-efficacy may affect teachers' job satisfaction.

Method

This research, which aims to determine relationships between school climate, self-efficacy, and job satisfaction, is correlational. The study utilized structural equation modeling (SEM) analysis to examine school climate's direct effect on job satisfaction and indirect effect through self-efficacy. School climate is independent, self-efficacy is mediating, and job satisfaction is dependent variable in the constructional model.

Figure 2

Model of the Research



According to Figure 2, the effects of "teachers' perceived disciplinary, Teacher-student relations and participation among stakeholders", which are the subscales of the school climate, are independent variables. The reason why the subscales of the school climate are evaluated separately is that the scale is not able to get the total score and the

discipline subscale is aimed to measure a negative aspect of the school climate since it contains negative expressions.

Participants and Procedures

In the research, we used the TALIS (2018) data concluded by the OECD. The OECD shares this data on its official website (https://www.oecd.org/education/talis/talis-2018-data.htm). TALIS 2018 consists of the data collected from school principals and teachers from 48 countries, including Turkey. School levels in TALIS are named according to UNESCO classification. According to the UNESCO classification, the International Standard Classification of Education is expressed by the abbreviation ISCED. In TALIS, ISCED Level 1 refers to primary schools, ISCED Level 2 refers to secondary schools, and ISCED Level 3 refers to upper secondary schools. The participants from Turkey consisted of 171 school principals and 3204 teachers from 172 primary schools (ISCED Level 1); 196 school principals and 3952 teachers from 196 secondary schools (ISCED Level 2); and 448 principals and 8342 teachers from 457 upper secondary schools (ISCED Level 3) (OECD, 2019; UNESCO-UIS, 2012).

Only the data collected from teachers were used in this study. Since the data obtained from the OECD database are raw data, some adjustments have been made. For this purpose, the data of the participants containing missing data were excluded from the analysis. Within the scope of the research, we used the data obtained from a total of 12111 teachers, including 2461 from primary schools (20.3%), 3056 from secondary schools (25.2%), and 6594 from upper secondary schools (54.4%). 53% (6416) of those participating in the study are women and 47% (5695) of them are men.

Data Collection Tools

The data used in the research were obtained from three different measurement tools. The “School Climate Scale”, the first of these scales, consists of three subscales and 13 items (See Appendix 1). Scale items are four-point Likert type, and response options are “strongly disagree”, “disagree”, “agree” and “strongly agree” (OECD, 2019). After reliability analysis, we found .84 Cronbach alpha value for teachers’ perceived disciplinary dimension, .86 for teacher-student relations and .92 for participation among stakeholders dimension.

Another measurement tool used in the research is the “Teacher Self-Efficacy Scale”. The assessment tool consists of three subscales and 12 dimensions (See Appendix 2). The scale is in the four-point Likert type and the response options are “none”, “to some degree”, “a little” and “a lot” (OECD, 2019). After reliability re-made reliability analysis of the scale, Cronbach alpha value was found as .84 for self-efficacy in classroom management, .81 for self-efficacy in instruction, .84 for self-efficacy in student engagement, and .91 for the overall scale.

The last scale used in the research is Job Satisfaction Scale. The measurement tool consists of three dimensions and 13 items (See Appendix 3). The scale items are four-point Likert type ranging from “strongly disagree” to “strongly agree” (OECD, 2019). As a result of the re-made reliability analysis of the scale, the Cronbach alpha value was found as .79 for job satisfaction in the work environment, .79 for job

satisfaction with the profession, .86 for satisfaction with target class autonomy, and .82 for the overall scale.

Table 1

Reliability Coefficients of Measurement Tools Calculated by OECD

Variable		ISCED Level 1	ISCED Level 2	ISCED level 3
School Climate	Teachers' perceived disciplinary	.89	.90	.90
	Teacher-student relations	.91	.88	.88
	Participation among stakeholders, teachers	.91	.90	.90
Self-efficacy	Self-efficacy in classroom management	.86	.88	.86
	Self-efficacy in instruction	.85	.82	.82
	Self-efficacy in student engagement	.82	.81	.79
	Total self-efficacy	.93	.93	.92
Job Satisfaction	Job satisfaction with work environment	.85	.86	.85
	Job satisfaction with profession	.84	.86	.85
	Satisfaction with target class autonomy	.89	.90	.88
	Total job satisfaction	.89	.89	.89

Data Analysis

Two analyses were made in the study. The first one is about testing the reliability of measurement instruments in terms of the data obtained from the Turkey sample. SPSS Statistics 17.0 program was used at this stage. In the second analysis, structural equation modelling (SEM), the AMOS 16 package program was used. Whether the data is distributed normally is a basic criterion in the confirmatory factor analysis (Bayram, 2016). Within the scope of the structural equation model analysis, a theory-based model has been constructed to test the relationship between variables. There are different opinions about which fit indices to use. According to Kline (2011), it is sufficient to report chi-square, RMSEA, CFI and SRMR. Jackson et al. (2009) stated that the most frequently reported fit indices in SEM studies were chi-square and degrees of freedom, CFI, RMSEA, and TLI. However, Brown (2014) states that using the chi-square statistic to evaluate the goodness of fit in studies with a large sample size can be misleading because this value is very sensitive to the sample size. In our research, the chi-square statistic was not employed to evaluate goodness of fit since it was a large sample group consisting of 12111 participants. So, we decided to report RMSEA, CFI, TLI and SRMR fit indices. While values of .08 for RMSEA and .06 and below for SRMR are accepted; values of .90 and above were accepted for other goodness of fit criteria (Hu & Bentler, 1999; Karagöz, 2016).

In order to use multivariate statistical techniques, it is necessary to provide the assumption of multivariate normality. Multivariate normality means that the observations in the sample are normally distributed for all combinations of variables. Also, for multivariate normality, each variable must meet the univariate normality assumption. However, meeting the univariate normality assumption does not guarantee

that the multivariate normality assumption will be met (Çokluk et al., 2012; Mertler & Vannatta, 2005, cited in Akar, 2017). Skewness and kurtosis coefficients were used to examine univariate normality. The skewness and kurtosis coefficients of the measurement instruments vary between .065 and 1.605. The fact that the values obtained are within the acceptable limits in the literature indicates that the data are normally distributed (George & Mallery, 2010; Karagöz, 2016). To examine multivariate normality, Mardia's multivariate normality coefficient and critical ratio (c.r.) values were examined. It can be said that multiple normality is not achieved when the critical ratio value is greater than 5 (Yuan et al., 2005) and the Mardia coefficient is greater than 1.96 (Bayram, 2016). In the study, the Mardia coefficient was found to be 370,364 and the critical ratio value was 369,617. Since the data do not support the multiple normality assumption, a Bootstrap analysis was performed where the normal distribution was not required (Bayram, 2016).

Multicollinearity is another assumption of structural equation modeling. The results of the correlation analysis performed to understand whether there is multicollinearity between the variables are given in Table 2.

Table 2

Correlation Values between Variables

Variables	Job Satisfaction	Self-efficacy	Teachers' perceived disciplinary	Teacher-student relations	Participation among stakeholder
Job Satisfaction	1				
Self-efficacy	342**	1			
Teachers' perceived disciplinary	-.356**	-.273**	1		
Teacher-student relations	.417**	.314**	-.230**	1	
Participation among stakeholder	.407**	.220**	-.169**	.537**	1

**Correlation is significant at the .01 level (2-tailed).

When Table 2 is examined, the fact that the values of the correlation between the variables are below .80 can be interpreted as the absence of a multicollinearity problem (Büyüköztürk, 2006). After the normality and multicollinearity analyses, the measurement model, which is a confirmatory factor analysis (Bollen, 1989, cited in Akar, 2017) for the structural model, was tested. The fit index values obtained for the measurement model (CFI=.918, TLI=.912, RMSEA=.052, SRMR=.058) show that the model was confirmed.

Limitations

We used the data obtained from teachers in the research and excluded the school principals from the scope of the research. Further studies that may include analyses including school principals may allow comparisons and an overall generalization. Although TALIS 2018 data were collected from 48 countries and economies, the results were obtained from the Turkey sampling. If the scope of research can be adjusted

comprehensively enough to cover more countries, it may be useful in revealing the similarities and differences between cultures.

Ethical Procedures

Ethical board approval is not required as OECD data are used in this study.

Results

SEM tests whether the available data support a structure that is thought to exist. In this respect, in SEM, the model should be designed first and then the model should be tested whether it is verified with data. The path coefficients regarding the significance of the relationships in the model designed to test the direct effects of school climate on job satisfaction and its indirect effects through self-efficacy are given in Table 3.

Table 3

Model Path Coefficients

Relationships Between Variables	*B*	*β*	*S.E.*	*C.R.(t)*	*p*
Self-efficacy <--- Teachers' perceived disciplinary	-.134	-.221	.006	-21.72	***
Job Satisfaction<--- Teachers' perceived disciplinary	-.180	-.273	.007	-24.23	***
Self-efficacy <--- Teacher-student relations	.272	.275	.013	21.350	***
Job Satisfaction<--- Teacher-student relations	.232	.217	.015	15.785	***
Self-efficacy <--- Participation among stakeholders	.038	.056	.008	4.708	***
Job Satisfaction<--- Participation among stakeholder	.337	.465	.010	33.692	***
Job Satisfaction<--- Self-efficacy	.142	.131	.013	11.241	***

The path coefficients are expected to be significant in order for the model whose accuracy is tested in SEM to be valid. C.R. (t) value is checked for the significance of the path coefficients. If this value exceeds 1.96, it points out a level of significance at 0.05, and if it exceeds 2.56, it means there is a level of significance at 0.01 (Çokluk et al., 2014; Tabachnick & Fidel, 2001). Looking at Table 2, it is seen that all path coefficients in the model are significant. The second stage followed in the analysis of the model is related to the values of fit index. For the model to be acceptable, fit index values must be within the acceptance range (Byrne, 2010; Kline, 2011). Fit index values of the model were calculated as CFI=.918, TLI=.912, RMSEA=.052, SRMR=.058. These values are sufficient for the model to be acceptable (Hu & Bentler, 1999; Karagöz, 2016). It can be suggested that the model constructed with the path coefficients and fit index values obtained from SEM result is confirmed with the data obtained from the sample group. The model verified with fit index values is given in Figure 3.

Figure 3

Mediating Effect of Self-Efficacy in the Relationship between School Climate and Job Satisfaction

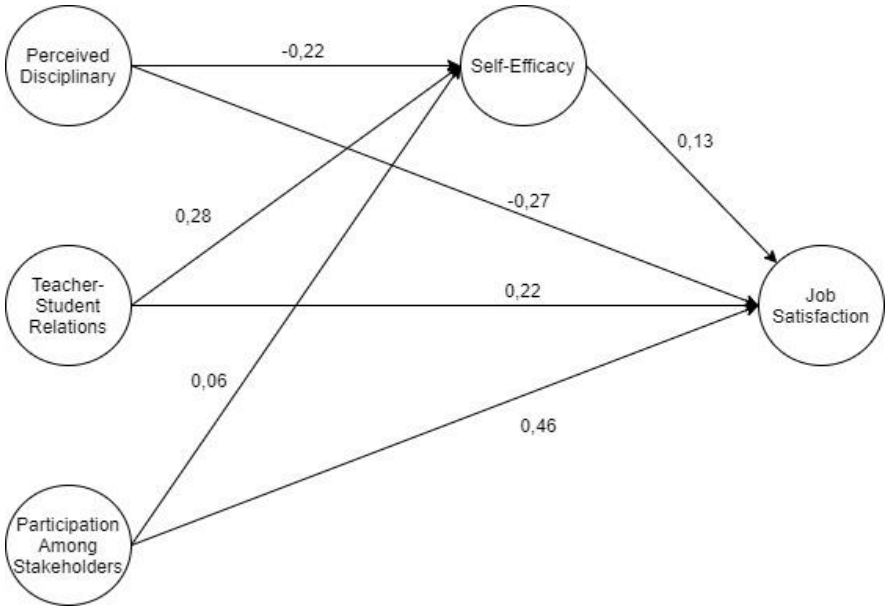


Figure 3 illustrates that all dimensions of school climate directly affect job satisfaction. The indirect effects of school climate on job satisfaction through self-efficacy were calculated using the bootstrapping method. Teachers' perceived disciplinary dimension of the school climate has an indirect effect on job satisfaction. The standardized coefficient for indirect effect was calculated as 0.010 (indirect effect [-0.034, -0.023] for 95% confidence interval). Teacher-student relationships also have an indirect effect on job satisfaction. The standardized coefficient for indirect effect was calculated as 0.010 (indirect effect [0.029, 0.043] for 95% confidence interval). The dimension of participation among stakeholders was found to affect job satisfaction indirectly. The standardized coefficient for indirect effect was calculated as 0.010 (indirect effect [0.005 -0.011] for 95% confidence interval). The dimensions of the school climate and the perception of self-efficacy account for 61% of the variance in teacher job satisfaction. The dimensions of school climate also account for 18% of the variance in self-efficacy perception. Standardized effects showing direct and indirect effects in the model are given in Table 4.

Table 4

Standardized Effects of the Mediating Model

Relationships Between Variables	*Direct effect*	*Indirect effect*	*Total effect*
Self-efficacy <--- Teachers' perceived disciplinary	-.221	---	-.221
Job Satisfaction<--- Teachers' perceived disciplinary	-.273	-.029	-.302
Self-efficacy <--- Teacher-student relations	.275	---	.275
Job Satisfaction<--- Teacher-student relations	.217	.036	.254
Self-efficacy <--- Participation among stakeholders	.056	---	.056
Job Satisfaction<--- Participation among stakeholder	.465	.007	.472
Job Satisfaction<--- Self-efficacy	.131	----	.131

Given the standardized path coefficients in Table 4, it is seen that the dimensions of teachers' perceived disciplinary, teacher-student relations and participation among stakeholders belonging to the school climate variable have direct and indirect effects on job satisfaction. Regarding the direct effects, a one-unit increase in the perception of discipline causes a -.221 decrease in the perception of self-efficacy and a -.273 unit decrease in the perception of job satisfaction. One-unit increase in the perception of teacher-student relationships increases the perception of self-efficacy at .275 level and job satisfaction at .217 level. One unit increase in the perception of participation can create a change of .056 units in the perception of self-efficacy, while it can create a change of .465 units in the perception of job satisfaction. One-unit increase in self-efficacy causes an increase of .131 units on job satisfaction. When the indirect effects are examined, the effect of the perception of discipline on job satisfaction through self-efficacy was calculated as -.029, while the total effect was calculated as -.302. While the indirect effect of teacher-student relationships on job satisfaction through self-efficacy was .036, the total effect was found to be .254. Finally, while the indirect effect of participation among stakeholders on job satisfaction through self-efficacy was calculated as .007, the total effect was calculated as .472.

Discussion and Conclusion

According to the results revealed self-efficacy directly affects the job satisfaction. While the perceived disciplinary dimension of the school climate directly and negatively affects job satisfaction, the dimensions of teacher-student relations and participation among stakeholders of the school climate directly and positively affect job satisfaction. Finally, all dimensions of school climate also indirectly affect job satisfaction through self-efficacy.

The result that the perception of self-efficacy has a direct and positive effect on job satisfaction, found in this research, is parallel to the results of the study conducted by Zakariya (2020). Zakariya (2020) used TALIS 2018 data of the Norwegian middle school teachers in his research and found that self-efficacy directly affects job satisfaction. Likewise, Katsantonis (2020) concluded that self-efficacy has a direct effect on job satisfaction due to the research using TALIS 2018 data obtained from primary school teachers from 15 countries, including Turkey. Malinen and Savolainen (2016) also detected that teachers' self-efficacy directly affects job satisfaction. In her meta-analysis of 35 studies, Kalkan (2020) concluded that the general effect size of the relationship between teachers' self-efficacy beliefs and job satisfaction levels is positive and moderate. When the literature is examined, it is possible to reach the results of many domestic and foreign pieces of research on the effect of self-efficacy on job satisfaction (Aldridge & Fraser, 2016; Caprara et al., 2003, 2006; Edinger & Edinger, 2018; Köksal, 2019; Ruma et al., 2010; Seyhan, 2015; Skaalvik & Skaalvik, 2014; Telef, 2011; Turcan, 2011; You et al., 2017)

The conclusion that the perceived disciplinary dimension of the school climate has a direct and negative effect on job satisfaction is similar to the studies of Zakariya (2020) and Katsantonis (2020). The negative impact of the perception of discipline should be evaluated considering that the items that make up this dimension of the measuring tool contain negative statements. In schools and classrooms where the implementation of the rules is problematic, teachers' job satisfaction is negatively

affected by the increased effort and time they spend to provide discipline. It is also possible to see similar results in OECD's 2013 TALIS research. It has been reported that countries and economies where students with behavioral problems have a higher percentage have lower job satisfaction among teachers (OECD, 2014).

The teacher-student relations dimension and participation among stakeholders dimension of the school climate also have a direct effect on job satisfaction. This effect is not negative as found in the perceived disciplinary dimension but positive. The result that school climate has an effect on job satisfaction supports the study of Polat (2018), in which she found significant positive relationships between job satisfaction level and organizational climate. The result obtained also shows parallelism with Mert and Özdemir's (2019) study, which found a moderately positive relationship between teachers' job satisfaction and psychological climate. It is also possible to come across other research results suggesting that school climate directly affects job satisfaction (Aldridge & Fraser, 2016; Katsantonis, 2020; Malinen & Savolainen, 2016; Zakariya, 2020). Studies in which sample groups are from different countries show that positive perceptions of school climate and student behavior positively affect teacher job satisfaction. OECD's (2014) 2013 TALIS study reveals that the indicators of school climate predict job satisfaction

The perceived disciplinary dimension of the school climate negatively affects job satisfaction through self-efficacy. There are studies supporting this result. Raudenbush et al. (1992) point to a reciprocal effect between the perceived self-efficacy of the teacher and the student's achievement. Teachers' perceptions of self-efficacy are also high in schools with successful and good-natured students. For this reason, the high number of students with behavioral problems may negatively affect teachers' self-efficacy perceptions and job satisfaction. In the studies of Zakariya (2020) and Katsantonis (2020), the perceived disciplinary dimension indirectly affects job satisfaction through self-efficacy.

The dimensions of teacher-student relations and participation among stakeholders of the school climate positively affect job satisfaction through self-efficacy. The finding obtained supports Veldman et al. (2013). Veldman et al. (2013) found that the quality of teacher-student relationship affects teacher job satisfaction. It is also possible to come across other studies on the indirect effect of school climate (Aldridge & Fraser, 2016; Katsantonis, 2020; Malinen & Savolainen, 2016; Zakariya, 2020).

According to Bandura (2012), the perception of self-efficacy is affected by the environmental conditions the person is in. Similarly, Gibson and Dembo (1984) pointed out that teacher competence is relative and may not be generalized from one situation to another. With a similar point of view, Hoy and Woolfolk (1993) argued that teachers' sense of competence would be affected by the school climate. In other words, perception of self-efficacy is not a fixed variable; while it is affected by other variables in one aspect, it can affect other variables in the other. For teachers, school climate can create conditions that affect their self-efficacy beliefs, which may affect teacher job satisfaction. The fact that the school climate indirectly affects job satisfaction through self-efficacy, which is a finding obtained from the current study, supports this view.

The results obtained from this research provide information about the relationships of school climate, self-efficacy and job satisfaction. The dimensions of the school climate have a direct effect on teachers' job satisfaction. In addition to this direct effect, the dimensions of school climate indirectly affect job satisfaction through teacher self-efficacy. Understanding this relationship is highly important in terms of determining effective teachers and sustainability of effectiveness. Some researchers found that teachers' internal evaluations of their work were a strong indicator of staying in the teaching profession and predicted teachers' intention to leave their professions (McConnell, 2017; Schaufeli & Salanova, 2007). Although leaving the job does not seem like an option in Turkey, where finding a job in general and being employed as a teacher, in particular, is a serious problem, it can be suggested that teachers' internal evaluations of their work will have serious effects on their performance. In order to increase teachers' internal evaluations positively, steps should be taken to strengthen the perceptions of participation among stakeholders and teacher-student relations, which directly and indirectly affect job satisfaction in a positive way. For this purpose, teachers and other school stakeholders' participation in decision-making process can be increased. For teachers to get to know their students better and strengthen their interaction, class sizes and course load can be reduced and consultancy activities can be increased. The current study found that negative student behaviors negatively affect self-efficacy and job satisfaction. Improving teachers' self-efficacy perceptions about their capacity to influence and change unwanted student behavior can counteract this negative effect. It may be beneficial to support teachers with in-service training activities and increase their competencies, especially in schools where many students have behavioral problems.

Statement of Responsibility

Yusuf Türker; design of research process, data collection, data analysis, writing review and editing. Ümit Kahraman; design of research process, methodology, data analysis, supervision, translate.

Conflicts of Interest

There are no conflicts of interest in this study.

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Appendixes

Appendix 1

T3DISC: Teachers' perceived disciplinary climate	
TT3G41: How strongly do you agree or disagree with the following statements about this <target class>?	
Response options: "Strongly disagree" (1), "Disagree" (2), "Agree" (3), "Strongly agree" (4).	
TT3G41A	When the lesson begins, I have to wait quite a long time for students to quieten down
TT3G41B*	Students in this class take care to create a pleasant learning atmosphere
TT3G41C	I lose quite a lot of time because of students interrupting the lesson
TT3G41D	There is much disruptive noise in this classroom
T3STUD: Teacher-student relations	
TT3G49: How strongly do you agree or disagree with the following statements about what happens in this school?	
Response options: "Strongly disagree" (1), "Disagree" (2), "Agree" (3), "Strongly agree" (4).	
TT3G49A	Teachers and students usually get on well with each other.
TT3G49B	Most teachers believe that the students' well-being is important.
TT3G49C	Most teachers are interested in what students have to say.
TT3G49D	If a student needs extra assistance, the school provides it.
T3STAKE: Participation among stakeholders, teachers	
TT3G48: How strongly do you agree or disagree with these statements, as applied to this school?	
Response options: "Strongly disagree" (1), "Disagree" (2), "Agree" (3), "Strongly agree" (4).	
TT3G48A	This school provides staff with opportunities to actively participate in school decisions.
TT3G48B	This school provides parents or guardians with opportunities to actively participate in school decisions.
TT3G48C	This school provides students with opportunities to actively participate in school decisions.
TT3G48D	This school has a culture of shared responsibility for school issues.
TT3G48E	There is a collaborative school culture which is characterised by mutual support.

* Item was reverse coded.

Appendix 2

T3SELF: Teacher self-efficacy, composite	
T3SECLS: Self-efficacy in classroom management (subscale)	
TT3G34: In your teaching, to what extent can you do the following?	
Response options: "Not at all" (1), "To some extent" (2), "Quite a bit" (3), "A lot" (4).	
TT2G34D	Control disruptive behaviour in the classroom
TT2G34F	Make my expectations about student behaviour clear
TT2G34H	Get students to follow classroom rules
TT2G34I	Calm a student who is disruptive or noisy
T3SEINS: Self-efficacy in instruction (subscale)	
TT3G34: In your teaching, to what extent can you do the following?	
Response options: "Not at all" (1), "To some extent" (2), "Quite a bit" (3), "A lot" (4).	
TT2G34C	Craft good questions for students
TT2G34J	Use a variety of assessment strategies
TT2G34K	Provide an alternative explanation, for example when students are confused
TT2G34L	Vary instructional strategies in my classroom
T3SEENG: Self-efficacy in student engagement (subscale)	
TT3G34: In your teaching, to what extent can you do the following?	
Response options: "Not at all" (1), "To some extent" (2), "Quite a bit" (3), "A lot" (4).	
TT2G34A	Get students to believe they can do well in school work
TT2G34B	Help students value learning
TT2G34E	Motivate students who show low interest in school work
TT2G34G	Help students think critically

Appendix 3

T3JOBSA: Job satisfaction, composite	
T3JSENV: Job satisfaction with work environment (subscale)	
TT3G53: We would like to know how you generally feel about your job. How strongly do you agree or disagree with the following statements?	
Response options: "Strongly disagree" (1), "Disagree" (2), "Agree" (3), "Strongly agree" (4).	
TT3G53C*	I would like to change to another school if that were possible
TT3G53E	I enjoy working at this school
TT3G53G	I would recommend this school as a good place to work
TT3G53J	All in all, I am satisfied with my job
T3JSPRO: Job satisfaction with profession (subscale)	
TT3G53: We would like to know how you generally feel about your job. How strongly do you agree or disagree with the following statements?	
Response options: "Strongly disagree" (1), "Disagree" (2), "Agree" (3), "Strongly agree" (4).	
TT3G53A	The advantages of being a teacher clearly outweigh the disadvantages
TT3G53B	If I could decide again, I would still choose to work as a teacher.
TT3G53D*	I regret that I decided to become a teacher
TT3G53F*	I wonder whether it would have been better to choose another profession
T3SATAT: Satisfaction with target class autonomy	
TT3G40: How strongly do you agree or disagree that you have control over the following areas of your planning and teaching in this <target class>?	
Response options: "Strongly disagree" (1), "Disagree" (2), "Agree" (3), "Strongly agree" (4).	
TT3G40A	Determining course content
TT3G40B	Selecting teaching methods
TT3G40C	Assessing students' learning
TT3G40D	Disciplining students
TT3G40E	Determining the amount of homework to be assigned

* Items were reverse coded.

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Algorithmic Thinking Skills without Computers for Prospective Computer Science Teachers

Bilgisayar Öğretmen Adayları için Bilgisayar Kullanmadan Algoritmik Düşünme Becerileri

Çetin GÜLER*

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ABSTRACT: Algorithmic Thinking (AT) skills may be considered one of the necessary skills for everyone in the new century. Individuals and societies live in a time when they cannot avoid using information communication technologies (ICT). Hence, they need to be ICT literate. Teachers shall play an important role both for individuals and societies to address this need. However, are they ready to play such a role? This paper presents a suggestion for teacher training to help teachers how to play the role. The paper suggests including an elective course under the title AT into the computer science teacher training curricula and aims to present the course, progress and views of the students who took the course. A mixed-method approach was followed for the current study. The study was carried out with the participation of sixth-semester students of a Computer Education and Instructional Technology Department of an Education Faculty who may be considered prospective computer science teachers. Twenty-eight students were enrolled in the elective AT course offered for the period. Within the scope of the study, development of the course curriculum, instructional process of the course and evaluation of the course, in line with students' views and exam scores, are presented. Findings of the research suggest that the students find the Algorithmic Thinking course helpful for them to acquire some algorithmic thinking skills as well as some other academic and life-related thinking abilities. Also, the course may be considered as a necessary course particularly for the training process of computer science teachers. In addition, the students think that the offered course was effective and beneficial.

Keywords: Algorithmic thinking, computational thinking, computer science, course, prospective teacher.

ÖZ: Algoritmik düşünme becerileri bu yüzyılda yaşayan herkes için gerekli bir özellik olarak düşünülebilir. Günümüzde bireyler ve toplumlar bilgi iletişim teknolojilerini (BİT) kullanmak durumunda kalıyorlar. Bu durum onların BİT okuryazarı olmalarını gerektirmektedir. Bu gerekliliğin karşılanmasında öğretmenlere önemli görev düştüğü söylenebilir. Bu çalışmada, bilişim teknolojileri öğretmen adayları için Algoritmik Düşünme adıyla sunulan seçmeli bir ders ele alınmıştır. Çalışmada karma yöntem yaklaşımı izlenmiştir. Çalışma, bir Eğitim Fakültesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü altıncı yarıyılında öğrenim gören bilgisayar bilimleri öğretmen adayları ile gerçekleştirilmiştir. Söz konusu dönem için açılan seçmeli dersi 28 öğrenci almıştır. Çalışma kapsamında öğrencilerin görüşleri ve sınav puanları doğrultusunda dersin öğretim süreci ve dersin değerlendirilmesine yer verilmiştir. Bununla beraber ders programının gelişim sürecine de yer verilmiştir. Araştırmanın bulguları, öğrencilerin bazı algoritmik düşünme becerilerinin yanı sıra diğer akademik ve yaşamla ilgili düşünme becerilerini kazanmaları noktasında Algoritmik Düşünme dersini yararlı bulduklarını göstermektedir. Ayrıca ders, özellikle bilgisayar bilimleri öğretmenlerinin yetiştirilmesi açısından gerekli bir ders olarak değerlendirilebilir. Ek olarak öğrencilerin, sunulan dersin etkili ve faydalı bir ders olduğu yönünde görüşler belirttikleri de belirtilebilir.

Anahtar kelimeler: Algoritmik düşünme, bilgi-işlemsel düşünme, bilgisayar bilimleri, ders, öğretmen adayı.

* *Corresponding Author*: Assoc. Prof. Dr., Van Yüzüncü Yıl University, Van, Turkey, cetin@yyu.edu.tr, https://orcid.org/0000-0001-6118-9693

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Algorithmic Thinking

Learning to code, developing programs and developing computational thinking (CT) skills are considered as qualifications that today's individuals should have in order to cope with the situations they face and may encounter (Kalogiannakis & Papadakis, 2017b). In the context of information communication technologies (ICT) and education, particularly in recent years, one of the centers of interest is computational thinking (CT). CT may mainly be considered to be related to AT and programming (Angeli & Valanides, 2020; Citta et al., 2019; Zhang & Nouri, 2019; Zhao & Shute, 2019). In fact, CT and AT are concepts that are interchangeable/equivalent and sometimes used instead of each other (Hromkovic et al., 2017; Pérez-Marín et al., 2020). The use of computational algorithmic thinking (CAT) concept (Thomas et al., 2017) is also considered the same. On the other hand, using a proper term that can encompass CT can be tricky for some cultures. For example, in Turkish, there are many terms that are similar but not the same for the term CT. Even though AT was presented as a factor under CT, AT can encompass all attributes of CT. Since some scholars use them interchangeably, AT can be a more familiar and widely accepted term, and AT will be used to encompass all of these terms for the purpose of this paper.

The term algorithm is named after al-Khwārizmī (Knuth, 1985). However, AT is an old form of thinking extending back to Pythagoras and the Jewish Kabbalah (Essl, 2007). For most people, the word algorithm can suggest something about computer science or programming. However, AT is not merely a way of thinking associated with computer science or programming (Hubalovsky & Korinek, 2015; Mayer, 1981). AT can be considered more of a form of thinking associated with problem-solving (Aho, 2012; Wing, 2006). Futschek (2006) defines AT as a pool of skills that can be used to understand and develop algorithms. It can be argued that lifelike experiences should be utilized in creating this skill pool (Hubalovsky & Korinek, 2015). AT can be described as high-level intellectual actions involving understanding problem situations, finding systematic and generalizable solutions to solve the problems, checking the accuracy and efficiency of the solutions and expressing these solutions step by step.

AT and Education

It was claimed that AT would affect every individual in every area of society (Wing, 2008). In this context, the search for inclusion of AT in educational programs continues (Dagiene et al., 2017; Grover et al., 2015). In many countries, including the USA and the UK, there are endeavors to include AT in education curriculums, particularly as an important part of the K-12 level curriculums (Dagiene et al., 2017; Papadakis & Kalogiannakis, 2019). When the place and the importance of ICT are considered today, being an ICT literate society is a necessity (Galezer et al., 1995; Gao et al., 2011). Teachers can be considered the most important actors in meeting this necessity by being effective role models (Gao et al., 2011). The first condition that teachers can fulfill this role is that teachers should be ICT literate themselves (Ayaz et al., 2015). Having AT skills can be considered as a prerequisite for ICT literacy (Galezer et al., 1995). Therefore, the teachers who will guide their students to gain AT skills should have AT skills. According to Cooper et al. (2000), many university students (including students in computer science) do not have AT skills. Despite the fact that it is twenty years old, Cooper's claim may remain valid for some students. When considering that the basic requirement for computer

programming is AT (Bryant, 2017), it can be claimed that the basic requirement for acquiring ICT literacy is to acquire AT skills (Aho, 2012; Milkova & Sevcikova, 2017). Therefore, it is proposed to provide training for the development of AT skills before the training in the context of algorithms and program development (Ham, 2015; Hubálovský, 2013).

Including AT teaching into the curricula for all educational levels may be considered valuable (Kalogiannakis & Papadakis, 2017a, 2017b; Papadakis & Kalogiannakis, 2019). Most of the arrangements and updates within K-12 curriculums related to AT are associated with coding and computer program development in various countries (Dagiene et al., 2017). It is known that teaching programming is a challenging process (Grover et al., 2015). However, it is more difficult to teach the programming concept and structure than to teach a programming language in this process (Athanasiou et al., 2017). Brusilovsky et al. (1997) and Hubálovský et al. (2010) pointed out that a traditional approach is often used in teaching programming. In this conventional approach, problem situations are often used, which require the number and symbols to be processed through a general-purpose programming language. Even if the execution process of this approach involves algorithms, the main purpose is to teach a programming language (Galezer et al., 1995). Consequently, students do not acquire AT skills due to their intense effort to learn the programming language and inappropriate teaching practices (Grover et al., 2015; Hubálovský et al., 2010; Plerou et al., 2017). This approach is not effective particularly for younger students (Brusilovsky et al., 1997; Dagiene et al., 2017). Hence, students may find CS confusing and difficult (Papadakis, 2020) and grow some negative attitudes. Students who are expected to learn programming skills should first have AT skills (Hubálovský et al., 2010; Hunter, 1987) to address these difficulties. So, learning process of a programming language can be realized more effectively. From this point of view, it can also be argued that individuals with AT skills are more likely to be ICT literate.

As aforementioned, one of the most important factors for the students to gain AT skills is teachers. Teachers' beliefs, perceptions and attitudes related to AT influence both their practices and teaching approaches of AT (Kordaki, 2013). Therefore teachers, particularly computer science teachers should be trained to have AT skills and to have positive beliefs, perceptions and attitudes towards to the AT. Unfortunately, it can be claimed that the prospective computer science teachers graduate without having sufficient AT skills. Additionally, it is also stated that there are few studies on AT (Katai, 2015; Plerou et al., 2017) and no compromise on how AT skills can be gained (Grover et al., 2015; Milková, 2005; Milkova & Sevcikova, 2017; Silapachote & Srisuphab, 2017).

Purpose and the Significance of the Research

In the light of the aforementioned literature, a need to include AT in teacher training processes, particularly for prospective computer science teachers reveals itself. The need for the studies that are examining how to teach AT skills remains unsatisfied as well. In order to meet these needs, an elective course offered under the title of AT for prospective computer science teachers. The aim of the work presented in this paper is to examine this course. The work presents the curriculum development of the course, the instructional process of the course, and the evaluation of the course in the light of students' views and by exams' scores (the midterm and the final exams). Since there is a very

limited number of studies subjecting an AT specific course and training process for prospective computer science teachers and considers the aforementioned issues, this work may add meaningful contributions to the field.

Research Questions

"What are the views of the students about the AT course?" is the research question of this study. Sub questions of the study are as follows: (i) Was there a difference in exams' scores averages of the students? (ii) What are the views of the students about the AT course objectives? (iii) What are the views of the students about the AT course content? (iv) What are the views of the students about the AT course implementation? (v) What are the views of the students about the AT course evaluation? (vi) What are the views of the students about the AT course effect?

Method

A mixed method approach was followed and sequential explanatory design was conducted for the current study. The qualitative data were collected after the implementation of the course to both contributing quantitative findings and evaluation of the course. Quantitative part was designed as one group quasi experimental study. The details of the process of the research are given in the sections Participants and Context, AT Course Curriculum Development and Procedure.

Participants and Context

This study was carried out with the participation of sixth semester students of Computer Education and Instructional Technology Department of an Education Faculty. The participants may be considered as prospective computer science teachers. Twenty-eight students were enrolled in the selective AT course opened for this period. Ten of these students are female (35%), 18 are male (65%). However, the number of students who indicated their views on the course was 20. Some of the lessons that these students have to take are Programming Language I and II, Internet Based Programming, Database Management Systems. Also, there is a compulsory lesson (Algorithm Design and Development) that directly includes teaching algorithms or AT in their new curricula. Although Programming Languages I and II courses require some algorithm-related skills, teaching algorithms or AT do not sufficiently occur in these courses neither. Besides, the new course of new curricula seems to be the Programming Language I course in a different name, in practice. As aforementioned (see Introduction) studies suggested that such conventional approaches may not be effective enough to gain AT skills. Therefore, a course subjected to AT was deemed necessary and beneficial for these students.

AT Course Curriculum Development

Curriculum development model known as Taba-Tyler or rational planning was used for the development of the AT course curriculum. Accordingly, a curriculum has four basic components. These components are the objectives, content, learning experiences and evaluation. The objectives of the course were determined and assessed with the help of five academicians and relevant literature. The main objective of the AT course is to contribute to the development of AT skills of prospective computer science teachers. Students who take this course are expected to acquire the skills to produce sequential, logical solutions to problems they may encounter in different subjects areas and in all areas of life (as

suggested by: Papadakis, 2020; Papadakis & Kalogiannakis, 2019). However, in the light of the relevant literature, it has been evaluated that the use of any programming language during the development of these skills will adversely affect the process. Therefore, only the pseudo-codes (Grover et al., 2015) and flow charts have been decided to be used within the learning-teaching process. Since puzzles are supposed to contribute logical evolution and imagination (Milková & Hùlková, 2013) and AT skills (Hsu & Wang, 2018), selecting these questions from puzzles is deemed appropriate. For this purpose, puzzles from Algorithmic puzzles book written by Levitin and Levitin (2011) was decided to be used.

Procedure

The AT course is offered as a four-hour course (two lectures and two labs) each week for a term of 14 weeks. During the first week, general information about the course and explanations were given. Later on, students' opinions about developing algorithms were asked to determine readiness of the students. In the light of these opinions, it has been evaluated that some students have basic algorithm development knowledge and skills, but most of them do not have. Therefore, first of all, basic theoretical information about algorithm development, and how the developed algorithms can be expressed with pseudo codes and flow charts were subjected. During this step, basic steps of algorithm development, which are identifying and understanding a problem/situation, finding a solution, checking the solution for accuracy and efficiency and expressing solution step by step with pseudo-codes and flow charts, are given with simple and clear examples (e.g., finding the sum of two numbers, sum of ten numbers, ordering three numbers). Details on how to write pseudo-codes and draw flow charts were given as well. In the following weeks, the solution of the puzzles in the direction of the pre-determined curriculum and the development of the algorithms have been provided with both pseudo-codes and flow charts. The development of the algorithms was carried out with the participation of the students, providing an interactive environment within the classroom. The steps of expressing the developed algorithms with the pseudo-codes and flow charts were carried out individually by each student during the lab hours.

Except for the first two weeks, the implementation of the AT course was usually as follows. (i) Asking students a puzzle verbally, (ii) Recognizing the time required for students to keep notes on the puzzle, repeating points not understood at this stage, (iii) Asking students to express what they are asked by their own words, (iv) Waiting for two or three students to express puzzle correctly, (v) Asking all students whether the puzzle is being understood correctly, and clarifying the points that are not understood, (vi) Asking students to define what is given/input and what is asked/output, (vii) Asking students to offer solution/s for the puzzle, (viii) Ensuring that the solution/s offered by the students are evaluated by other students, (ix) Waiting until all the students agree on the solution/s, allowing them to discuss during, (x) Ensuring that the solution/s being agreed are understood by all, clarifying the points that are not understood, (xi) Having students to draw flow charts and write pseudo-codes for a solution of each puzzle individually during the lab hours.

Data Collection and Analysis

Exams' papers, the students' views, the students' works of lab hours are the collected data. The two exams, which were confirmed by two experts in CS and teaching

programming, were consisted of two questions where each one was relatively harder than the previous one. Students were asked to develop an algorithm for each question and express the algorithm in both pseudo-codes and flow charts, where each one of them assessed over 25 points (100 for the total). Students' views were gathered by seven online open-ended questions after the final exam. The questions were developed according to thematic structure presented by Zhao et al. (2017). The questions were designed to collect students' views on the course in general, outcomes, content, level, course implementation process, evaluation and effect. The questionnaire did not contain any questions about the identity of the students. Only gender and age information of the students were asked. Since the identities of the responders were unknown, the students had access to the questionnaire after their evaluation finished, and the voluntary nature of the participation have been considered as proof that the students reflected their sincere thoughts.

A Wilcoxon Signed Ranks test was conducted to compare exams' scores. For the descriptive analysis of the students' views, the thematic structure of what should be in a course curriculum presented by Zhao et al. (2017) was used. There are five themes in the related thematic structure and 16 code categories under these themes. The categories used are revised according to the nature of this study. As a result, nine categories were obtained under five themes (see Table 1). In the presentation of the findings, the students are coded as S1-S20.

Ethical Procedures

The study was designed in accordance with ethical principles and rules. The ethical committee approval number of the approval document is 5152763-604.01.02-E.36805.

Results

The first sub-question of the research is about the progress of the students according to exams' scores. In order to determine students' progress during the course process two exams were applied. These exams and their scorings were validated by the participation of three experts (all have the degree of Ph.D., one is in the field of measurement and evaluation, one is in computer science education and one is in computer engineering). According to the experts, both exams can be considered as equivalents and they are suitable for measuring students' progress in AT course. Therefore, even though the two exams consisted of different questions, based on the experts' views, their scores were treated as repeated measures. The exams' scores were examined and found not to be normally distributed. Therefore, a Wilcoxon Signed Ranks test was conducted to compare exams' scores. The test indicated that the final exam scores ($\bar{X}$=76.29, SD=10.08) were statistically significantly higher than midterm scores ($\bar{X}$=55.93, SD=5.28) Z=-4.51, p<.00. The results may suggest that the AT skills of the students showed some significant progress during the course.

The other sub-questions of the study are addressed by analyzing the responses that the students gave the questions. Themes and categories which reflects results of these questions with the code counts of the categories are presented in Table 1.

Table 1

Descriptive Analysis Themes, Categories Count and Percentages

Theme	Category	f	%
Curriculum Objective	Course related objectives	55	28
	Subject area related objectives	35	18
	Life related objectives	11	6
Curriculum Content	The level/grade of the course	29	15
	Scope of the course	17	8
Curriculum Implementation	Teaching-learning process	9	4
Learning Evaluation	Exams and students' work	5	3
Curriculum Effect	Satisfaction to curriculum	23	12
	Arouse students' interest in the curriculum	12	6
Total		196	100

The themes given in Table 1 are presented in an order as they asked in sub-questions.

Course Related Objectives

In the students' views, emphasizing was mostly found on the intellectual processes required for AT course. According to this, students have developed systematic, analytical and multifaceted thinking skills within the scope of this course and have put into practice the intellectual processes of reasoning. A student stated that "the puzzles that are asked in the lessons lead to systematic thinking and that we have to perform logical thinking action at a high level in the solution process." (S7), which may imply that they provide systematic thinking and were forced to be in more intellectual reasoning processes. Another student stated that "allows a person to think systematically and in such a way that computers can understand" (S15), indicating that, in addition to systematic thinking, students thought they could express the solutions in a computational way.

Subject Area Related Objectives

In this context, the students have mostly expressed their achievements in computer program development. A student stated, "I became aware of my programming knowledge. Along with that, it provided me with information on what to do and how to improve myself. I found out what my missing information about programming is "(S5), which indicates that the students who have taken courses related to computer programming have made more sense of information they already learned with AT course. Another student stated, "It was a very beneficial lesson that allows me to approach with different perspectives when writing a program." (S8), which demonstrates that AT course can enrich computer program development processes.

Life Related Objectives

Students' expressions in this context indicate that students have achieved some gains not only in situations facing palpable solutions, but also in seeing and being open to different aspects of events. A student stated, "You think differently, and there is not a single way to arrive at the end, not being on the same path does not really show that one of them is wrong." (S18), which can be regarded as a sign of a gain that can be useful even in conflicts of opinions that can be encountered in every aspect of life. The statement of another student, "I learned that there is a solution for every problem in my life" (S2) could be regarded as a positive achievement in order to demonstrate an effort to avoid giving up in the face of problems and to seek different solutions. Another student stated, "It helps people have a thinking ability. We face many problems in our daily lives. At the very least, it helps us to find solutions to these problems." (S5), which can be considered that the AT course can be useful in solving problems that may be encountered in life.

The Level/Grade of the Course

In order to find out the students' views on what level/grade would make AT course more beneficial, they were asked the questions, "If you have opportunity to choose the level/grade that you will take AT course, what level/grade would it be? And why?". The count of students and their preferred levels/grades are as follows; four students at each stage of their learning life, two students in primary school, two students in middle school, nine students in high school, and 12 students in university. A student, pointing to the achievements of this course, "I think it would have been more beneficial if we took this course before high school, in secondary education or even primary education. We would have gained some intellectual skills in younger ages." (S10). As a matter of fact, some students also stated, "I think the course should be offered in high school or at the beginning of university education. It would be helpful not only in programming but also in different aspects of life." (S8), "It should be offered in every level of every school regardless the education they offer related to computer science or not." (S12). The other statements of the students on this topic can be interpreted as that this course is more essential for computer programming or coding and that this course should be taken before programming courses.

Scope of the Course

The statement, "It was very difficult for us to work with flow charts, since most of us did not know anything about it" (S8) refers to the fact that most of the students who were in the second term of their third year, do not have basic knowledge about algorithm development. Some other statements, "At the beginning of the course all necessary information (Algorithm, Flow Chart, etc.) would increase the yield." (S12), "In high school years they taught the flow charts in the programming class, but that is not enough in my opinion." (S11), "the course should have been handled in a fundamental way, assuming that all students knew nothing." (S15), and "In order to be able to understand the more efficient part, simple questions can be answered in the first place, and flow charts and pseudo-code can be written for these questions" (S4) also indicated that the students lack basic knowledge and skills related to algorithm development, even though they already received some computer programming courses. However, S11 emphasized that "the subjects related to algorithm development were covered within a lesson in high school years, but this was not enough.".

Learning-Teaching Process

A student's statement, "We find very different answers by discussing the problems" (S2), summarizes how the learning-teaching process of the course was realized. Another student stated, "It would be better if each student is given a question and resolved beforehand and discussed with other friends in class" (S6), which indicates that he preferred exercises to be carried out outside the class in the form of homework. Another student stated, "I think that a circle is made and more interactive; for example, we should not be so individual" (S18), suggesting that classroom interaction can be enhanced by changing the classroom layout. The same student thinks that it is better to do group work during lab hours. Another student stated, "The course was completely dependent on the practice and the imagination of oneself" (S15), pointing to the role of mental processes in these practices.

Exams and Students' Work

Some statements of the students on this subject are "I think that it takes a lot of time to answer a question during exams, and this is a negative aspect of the exam being an hour or two." (S5), "I would like it more if the exams were project formed homework" (S3), "It is a beneficial course, but it would be better if there were no grades." (S17), "It would have been better if more time was given for the exams." (S8), and "I think it would be more beneficial if we were working with groups instead of individuals." (S13). These statements can be interpreted as the fact that students want more time for exams and perform project works in groups outside of class hours instead of individual classroom activities.

Satisfaction to Curriculum

There are 23 codes in this category, and only one can be considered a negative view on the curriculum. Some students' views in this category are "We were learning and we were enjoying it" (S16), "We learned a lot and having fun, and there is nothing that man cannot achieve." (S6), "It was a very fun course and we both learned and stressed during the lessons" (S8), "Entertaining teaching." (S12), "It is fun because it is based on logic." (S3). These views of the students imply that they continue to enjoy the course during the term. However, when expressing these views, they also stated that they learned a lot, stressed, had fun, and etc., which express their satisfaction with the course.

Arouse Students' Interest in the Curriculum

None of the students' views coded under this category is negative. A student stated, "We realize our dreams. I started without knowing anything, but now I want to sit and work for hours." (S18), which indicates that the course had a positive effect on the interests and motivations of the students. Another student stated, "Thanks to this course, I can do the practices I cannot do before, and it is a hope for the future." (S13) that may be considered to be another indicator of gains achieved by this positive effect. A Statement of another student, "A good start for programming in the future." (S12), suggests a positive reflection of the achievements of the course in other fields.

Discussions and Recommendations

Main findings of the research are discussed in this section. After the discussions, some recommendations are given with respect to the related literature and the findings of this study.

Although the students have taken the AT course in the sixth semester of the third year, they have stated that they do not have sufficient (or even no) knowledge and skills regarding AT before taking the course. However, they provide rich insights about what they thought they gained by taking the course. The findings of this study demonstrate that according to students who did not train in AT in their previous education processes (which supported by exams' scores), that AT skills are necessary for them (Hubálovský, 2013) and that AT skills can be beneficial in both professional, academic and real life situations (Papadakis & Kalogiannakis, 2017). To be able to perceive and understand various problem situations (Coufal et al., 2017; Dasso et al., 2005), execute mental processes to solve problems (Coufal et al., 2017; Saeli et al., 2011), express the solutions found in systematic and generalizable structures (Hromkovič, 2006; Papert, 1993), evaluate the effectiveness and efficiency of solutions, be open to different viewpoints, gaining skills for analytical thinking (Saeli et al., 2011), and etc. can be shown among the achievements that students thought they gained. Since these students are prospective teachers who are supposed to take an important role in the preparation of ICT literate individuals and society, the need for such lesson can be better understood by assessing the importance of teachers (Ayaz et al., 2015; Gao et al., 2011; Hubálovský et al., 2010; Hubalovsky & Musilek, 2013; Kalogiannakis & Papadakis, 2017b; Papadakis, 2020; Papadakis & Kalogiannakis, 2019) in this preparation. Considering potential benefits of such a course as AT, other teacher training programs may consider including the course in their curricula as well.

While determining the course content, it is assumed that the students have at least some AT skills. However, in the implementation of the course, most of the students were found to have almost no AT skills. Therefore, it would be more beneficial for such a course to be prepared at the most basic level of content, assuming that the students do not have any skills about AT. Beginning with the concept of algorithm, the development process of algorithms and dealing with the usage of pseudo-code and flow charts to express developed algorithms with many examples can contribute to the effect and efficiency of the course. Expressing solutions in this way before switching to programming or coding can provide meaningful contributions to AT development (Fidge & Teague, 2009; Fincher, 1999; Hromkovic et al., 2017; Mayer, 1981).

Algorithmic puzzles have been determined and used for the course. Most of the students found this course beneficial and fun. In the learning-teaching process of the course, it may be more useful to use puzzles/problems that are open-ended, blurred and closer to real-life conditions (Dagiene et al., 2017; Hubalovsky, 2012; Hubálovský, 2013; Hubalovsky & Korinek, 2015) than traditional programming instructions (Brusilovsky et al., 1997). However, by evaluating the views of some students and readiness of students, using simple, well-known/common algorithmic problems in the first weeks of the course may provide positive contributions to the effect of the course. Related literature (Brusilovsky et al., 1997; Ham, 2015; Hubálovský et al., 2010) and findings of this study suggest that no programming languages or environments be used in the process of acquiring AT skills. Programming languages and environments such as Scratch, Alice,

Kodu, which are claimed to require no programming or coding skills, are also no exceptions. Even such programming languages and environments can limit the process of AT development of students, no matter they require mostly moving visual blocks rather than writing codes. Therefore, it may be more beneficial for the students in the AT class to realize algorithm development processes using only paper and pencils.

The students' views also suggest that this course should be given at least before giving any computer programming courses (Galezer et al., 1995) or early stages of learning life (Akpınar & Altun, 2014; Galezer et al., 1995; Grover et al., 2015; Hubalovsky & Šedivý, 2013; Katai, 2015). Considering the relationship between computer programming and AT (Coates, 2010; Hubalovsky, 2012; Hubálovský, 2013; Hubalovsky & Korinek, 2015), this course may be considered as one of the core courses in computer science education. After submitting this course (Hubálovský et al., 2010), a course in the form of AT II, including the development of computer programs, can be presented. The content of AT II course can include basic algorithms and data structures such as searching and sorting algorithms, list and linked list, queue and stack structures. In presenting these topics, the necessary theoretical information can be presented first and then the association with daily life can be made with proper examples, questions or puzzles. Solutions can be expressed in pseudo-codes and flow charts using the approach of the AT course and then these pseudo-codes and flow charts into any programming language. Such an AT II course can also provide effective gains for the use of AT skills in the software development process, as well as helping students to consolidate and improve AT skills. Alternatively, the content of the AT and AT II courses mentioned here can be intensified and presented under a single course. Such a course can be divided into AT for the first half of the period (first seven weeks) and AT II for the second half (the rest of the term).

Conclusion

According to the exams' scores and views of the students, the offered AT course may be considered an effective and useful course, despite some deficiencies and problems identified and reported. Consequently, such a course should be given in departments related to computer science. It might be useful to present courses and topics related to AT skills at different stages of education process. It may be more useful to give this course before computer programming courses. The use of no programming language but only the use of the pseudo-codes and flow charts may be considered an element in the positive outcomes of the course.

Limitations and Implications

Due to some official and administrative restrictions, the AT course could be opened in the sixth semester of the third year of the CEIT Department. Consequently, the students who took this course had already taken some computer programming-related courses in the previous terms. Whereas it makes more sense that AT course is given before such courses. Taking an AT course before or after these courses may influence students' feelings and thoughts about the course. Therefore, the term of the AT course given in, and therefore the characteristics of the course participants, may be regarded as a limitation for the research. A more complicated study with two similar participant groups can isolate this limitation. Offering an AT course before the computer programming courses for one group and after

for the other group then make participants evaluate the course can provide more meaningful findings in this context.

The researcher of this study is also the instructor of the AT course. This may have affected data collection and data analysis phases for various reasons. The researcher has been involved with the students during class hours, but he could not keep observational notes in this process. This shortcoming has been tried to be solved by keeping the research journals after the class hours. The students' views about the course were intended to be determined by the interviews, but the researcher decided that interviewing would not be appropriate by evaluating the conflicts of interest that could originate from the researcher's teaching role. Instead, at the end of the term and after the student's assessments were done, students' views were received by an online form, with student identities being kept confidential. With the contribution of an additional researcher/s, research can be conducted by employing various data collection methods, which may improve the quality of the findings.

Conflicts of Interest

There are no conflicts of interest in this study.

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A Collaboration Project on Education for Sustainability: Professional Development Needs of Turkish Preschool Teachers*

Sürdürülebilirlik İçin Eğitim Üzerine Bir İşbirliği Projesi: Türkiye'de Okul Öncesi Öğretmenlerinin Mesleki Gelişim İhtiyaçları

Savaş PAMUK** **Naciye ÖZTÜRK*****
Deniz PAMUK**** **Rıdvan ELMAS*******
Tülin GÜLER-YILDIZ****** **Gelengül HAKTANIR*********

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ABSTRACT: The purpose of this study was to determine the preschool teacher's professional development (PD) needs about education for sustainability (EfS) as the first stage of a PD project. The general knowledge of teachers on sustainable development (SD) and their experience in preparing and implementing EfS activities was investigated. The data were collected from 1126 participants via a survey to determine preschool teachers' knowledge level about SD and their practice to develop a PD program. Most preschool teachers acknowledge the term SD and revealed limited SD knowledge. Organizing learning centers and using outdoor learning environments on EfS were seen as challenging tasks for them. Few of them find themselves competent in family participation efforts for SD.

Keywords: Early childhood education, sustainable development, education for sustainability, professional development, preschool teachers.

ÖZ: Bu çalışma, mesleki gelişim (MG) projesinin birinci aşaması olarak, okul öncesi öğretmenlerinin sürdürülebilirlik için eğitim (SE) ile ilgili MG ihtiyaçlarını incelemektedir. Bu doğrultuda öğretmenlerin sürdürülebilir gelişme (SG) hakkındaki genel bilgileri ile sürdürülebilirlik için eğitim etkinliklerini hazırlama ve uygulama konusundaki deneyimleri araştırılmıştır. Öğretmenlerinin MG ihtiyaçlarını araştırmak için 1126 katılımcıdan bir anket aracılığı ile veri toplanmıştır. Bulgular, okul öncesi öğretmenlerinin çoğunun sürdürülebilirlik terimi hakkında sınırlı bilgiye sahip olduğunu göstermiştir. Ayrıca, öğrenme merkezlerinin bu amaçla düzenlenmesi ve açık havada öğrenme ortamlarının kullanılması katılımcılar tarafından zorlu görevler olarak görülmüştür. Katılımcıların küçük bir kısmı sürdürülebilirlik için aile katılımı çalışmalarında kendilerini yeterli bulmaktadır.

Anahtar kelimeler: Okul öncesi eğitim, sürdürülebilir gelişim, sürdürülebilirlik için eğitim, mesleki gelişim, okul öncesi öğretmenleri.

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** *Corresponding Author*: Dr., Akdeniz University, Antalya, Turkey, savaspamuk@gmail.com, http://orcid.org/0000-0001-8661-4262
*** PhD Candidate, Hacettepe University, Ankara, Turkey, nacye231@hacettepe.edu.tr, https://orcid.org/0000-0002-4253-8365
**** Assoc. Prof. Dr., Mersin University, Mersin, Turkey, denizkahriman@gmail.com, https://orcid.org/0000-0002-7028-6097
***** Assoc. Prof. Dr., Afyon Kocatepe University, Afyonkarahisar, Turkey, relmas@aku.edu.tr, http://orcid.org/0000-0001-7769-2525
****** Prof. Dr., Hacettepe University, Ankara, Turkey, tguler@hacettepe.edu.tr, https://orcid.org/0000-0002-9518-0336
******* Prof. Dr., Emeritus, Ankara University, Ankara, Turkey, gelengulhaktanir@gmail.com, https://orcid.org/0000-0002-0783-592X

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Most countries grapple with getting down too many problems: poverty, types of pollution, and loss of biological diversity. Recently, researchers have addressed these problems in many fields such as education, economy, and social policy. Further, politicians and activists put them down on their plan to deal with these problems. Sustainable development (SD) brings forward "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1988). Education for Sustainability (EfS) brings people of all ages to assume responsibility to conceive a sustainable future (Bonnett, 1999; UNESCO, 2002). SD was gradually advanced in a multidimensional idea, consisting of pillars of SD environmental, economic, and socio-cultural as a whole constitute EfS (UNESCO, 2005a, 2006). The scope of EfS aims to arrange "people of all walks of life to plan for, cope with, and find solutions for issues that threaten the sustainability of our planet" (UNESCO, 2005b). The existence of qualified teachers is significant to succeed in EfS goals (Panatsa & Malandrakis, 2018) since children among the age groups are active "agents" to initiate creating chances (UN, 2015). The early years are a "natural starting point" for continuing EfS for all children valued (Dyment et al., 2014), lifespan learning, and societal transformation (Centre for Environment and Sustainability, 2008; UNESCO, 2014). On the other hand, introducing early childhood education practices for sustainability (ECEfS) has been decelerating in recent years (Elliott & Davis, 2009).

Background

It is crucial to understand the scope of SD, the value of EfS, and how education affects teachers' concept of sustainability (Panatsa & Malandrakis, 2018). Teachers shape future citizens' behaviors while their practices are shaped and influenced by their ways of understanding and thinking (Nespor, 1987). Yet, the literature indicates that teachers possess a superficial understanding of SD (Borg et al., 2014). Furthermore, they attend to view EfS through the pillar of the environmental lens, consistently discounting economic and socio-cultural pillars (Borg et al., 2014; Pepper & Wildy, 2008). The research still focuses on the environmental pillar of SD in EfS (Bascopé et al., 2019). However, understanding the relationship among them has a pivotal role in the holistic awareness of the EfS (Berglund & Gericke, 2016). Although there is policy and curriculum pressure, many teachers have unnoticed the link between sustainability and the curriculum. (Nicholls & Thorne, 2017). Barriers to associating integrating EfS in the curriculum is a lack of awareness of its priority (Nicholls & Thorne, 2017), teachers' conceptions of EfS be limited in scope (Dyment et al., 2015), and inadequate to capture the essence of sustainability and its bearing within the curriculum (Australian Education for Sustainability Alliance, 2014).

The Motivation of the Project and the Study

According to Inoue et al. (2016), sustainability is a many-faceted concept. There are various groups, such as politicians, scientists and teachers, interpreting it differently. Sustainability as environmental issues rather than socio-cultural and economic pillars are primarily understood by teachers (Hill et al., 2014). Teachers perceive doing nature-based activities as EfS (Elliott & Davis, 2009). They neglect the economic and socio-cultural pillars. However, this sense of direction is not enough to address current sustainability crises and societal transformation (Inoue et al., 2016). Studies are limited to interventional as experimental and action research about EfS conducted with teachers

and far too little attention has been developed teachers' practices (Güler Yıldız et al., 2021). Thus, in-service education about sustainability is suggested to understand the scope of sustainability and plan and implement activities in the preschool classroom (Güler Yıldız et al., 2017). According to Nicholls and Thorne (2017), EfS practices could be improved by professional development (PD) in the classrooms. Therefore, a PD project for preschool teachers on EfS was proposed by Turkish and Korean researchers who came together Education for Sustainable Development World Project initiated by the World Organization for Early Childhood Education (OMEP) and carried out studies together to boost awareness of EfS among children and preschool teachers (Engdahl, 2015; OMEP, 2020).

The project has been funded by the Scientific and Technological Research Council of Turkey (TUBITAK) and the National Research Foundation of Korea (NRF) under the Bilateral Cooperation Program between Turkey and South Korea. The purpose of the project is to increase awareness of EfS among preschool teachers and to support them in integrating EfS into their classroom program and their practices through the medium of the PD modules, which include 7R themes (reduce, reuse, recycle, respect, reflect, rethink, redistribute) on the context of two countries for two years. Because 7Rs are the appropriate pedagogical framework in the preschool classroom to address EfS (Duncan, 2011; Engdahl & Rabušicová, 2011), researchers provide professional training to preschool teachers after developing PD modules, and then the modules will be revised concerning the output. Besides, the different teachers will be enrolled in the prospective training, and researchers will follow up the reflection of the training into the school setting. All PD modules and processes will be carried out and negotiated in cooperation with the Korean team (ECEESDPD, 2020).

This study is the first stage of the project and focuses on determining the preschool teacher's PD needs about EfS. The PD modules will be developed based on the findings of the study. Also, this study is significant since minority groups outside the English-speaking culture have been supported by the researchers (Elliott et al., 2020).

A Snapshot of SD/EfS and Preschool Program in Turkey

Turkey is seeking to reach 17 Sustainable Developmental Goals (SDGs) published in the UN Sustainable Development Agenda in 2015. Moreover, the Eleventh Development Plan for the years 2019-2023, which integrated SDGs, is implementing in Turkey. Concerning the plan, action plans and various projects like Save Your Food Project and Zero Waste are carrying out by ministries (Turkish Ministry of Environment and Urbanization, 2019, 2020). They are applying the projects not only in the public areas but also at the schools. In addition to the government's effort, non-governmental institutions can reach the goals and raise awareness about sustainability for the public and the preschool teachers. For instance, training is conducted to improve teachers' knowledge and practices on the environment by The Turkish Foundation for Combating Soil Erosion (TEMA, 2018).

In Turkey, preschool education refers to 36-72 months old children till starting primary school. In 2013, the preschool program called "Preschool Education Curriculum" as a framework was developed to guide preschool teachers' practices by the Turkish Ministry of National Education (MoNE). The concept of SD is not used in

this curriculum because it is not thematic but developmental. The curriculum supports all development areas of children in a holistic way. Teachers plan their monthly and daily educational process, classroom activities, assessment of children, and family involvements based on the objectives, which the teacher selects following children's development level and needs. Teachers can add new objectives into the program related to the current local, national, and worldwide issues. Moreover, using outdoor learning environments and organizing learning centers, such as art, science and music, are promoted (MoNE, 2013). Therefore, teachers can associate SD and EfS into their educational process while following up the national program.

The project aims to develop PD modules based on the preschool teachers' needs. Because there is a unique role to guide teachers investigating their knowledge, skills, and dispositions (Inoue et al., 2016). Some studies have been carried out on how teachers defined the concept of sustainability and SD (Güler Yıldız et al., 2017; Haktanır et al., 2010; Kahriman, 2016; Korkmaz & Güler Yıldız, 2017; Uğraş & Zengin, 2019). However, no single study exists on what PD needs of teachers about EfS, and research to date have not yet determined what teachers know and how their skills for sustainability under the national preschool education curriculum in the Turkish context. Therefore, the purpose of this study is to determine the preschool teacher's PD needs about EfS. Determining their needs is critical to prepare modules about ECEfS for the project so their knowledge and skills might be enacted with varied emphasis with PD modules. As a result, the following research questions were determined to investigate preschool teachers' PD needs:

1. What is the general knowledge of preschool teachers on SD and its pillars?
2. What is preschool teachers' experience in preparing and implementing EfS activities in the classroom?
3. What are the PD needs of preschool teachers for EfS?

Method

Sample

The sample consisted of 1126 pre-school teachers from 7 different geographical regions and 81 provinces of Turkey. Participants ranged in experience from zero to 43 years with a mean year of 14.02. Most of the participants identified as female (97.1%), and the rest were male (2.8%). Concerning education level, most of the participants' highest degree was a bachelor's degree (n=823; 73.1%), while 123 (10.9%) earned a master's degree, and 11 (1.0%) participants earned a doctoral degree. Among them, 366 (32.5%) of the participants reported working in a kindergarten classroom in a public school. In comparison, 463 (41.1%) of the participants reported working in a public preschool. Also, 42 (3.7%) of the participants reported working in a kindergarten classroom in a private school, while 254 (22.6%) of the participants reported working in a private preschool. In terms of the children age group of the teachers' classroom, 455 (40.4%) participants were working with 5-year-old children, 205 (18.2%) participants were working with mixed-age children, 192 (17.1%) participants were working with 6-year old children, 181 (16.1%) participants were working with 4-year old children, 83 (7.4%) participants were working with 3-year old children, and 9 (.8%) participants were working with 2-year old and under age group children.

Table 1

Some Demographic Information about Participants

Teachers'		n	%
Gender	Female	1093	97.1
	Male	32	2.9
Education Level	High School	18	1.6
	Associate degree	131	11.6
	Open Education Bachelor's degree	19	1.7
	Bachelor's degree	823	73.1
	Master's degree	123	10.9
	Doctoral degree	11	1.0
	Missing	1	.1
School Type	Public kindergarten classroom	366	32.5
	Public preschool	463	41.1
	Private kindergarten classroom	42	3.7
	Private preschool	254	22.6
	Missing	1	.1
Age of children in the classroom	Two and under of two	9	.8
	Three	83	7.4
	Four	181	16.1
	Five	455	40.4
	Six	192	17.1
	Mixed	205	18.2
	Missing	1	.1

Instruments and Procedure

For data collection, a survey was developed by the researchers. The survey's purpose was to determine preschool teachers' knowledge level about SD and its reflection on their practice in the classroom to develop a PD program. The intention was to reach as many preschool teachers as possible from all cities/regions of Turkey. The survey, which was carried out from March to May in 2020, consists of three parts: participants' demographics, views on EfS, and needs for implementing EfS in the preschool classrooms. In addition, there are questions about the participants' gender, teaching experiences, education, type of their institution, and children's age group of their classroom in the demographics section (Represented by seven questions).

Next parts aim to better understand participants' efficacies in knowing the SD concept, practicing EfS and their needs to implement EfS in their classroom. The second and third parts of the survey comprised 17 optional and close-ended questions (Six-point Likert scale from none/very poor/poor/fair/good/very good). Nine questions are also separated into three levels in the third part. These three levels are environmental, economic, and socio-cultural pillars of SD for every question in these

nine. Because of the survey structure, it is more appropriate to collect data on the descriptive level. Sample questions from the second and third parts of the survey are presented below (Table 2).

Table 2

Sample Questions from the Second and Third Parts of the Survey

8. Have you heard the concept of sustainable development before? Yes/No	If your answer is "yes," please mark where have you heard it from? a. From mass media (newspaper, internet, TV, etc.) b. From academic publications (books, articles, etc.), c. From workshops, seminars, or in-service training d. From the conversations I had with faculty e. Non-governmental Organizations (TEMA, ÇEVKO, TÜRÇEV, etc.) f. From the courses I took during my undergraduate education g. Other …….. (Please explain)						
		none	very poor	poor	fair	good	very good
15. Knowledge of concepts that I can address for education for sustainability	Environmental	1	2	3	4	5	6
	Economic	1	2	3	4	5	6
	Socio-cultural	1	2	3	4	5	6

The survey was made available to participants via google forms for a three-month interval. It was advertised through phone calls, social media such as Instagram, Facebook, Twitter, groups in messaging platforms; besides some phenomenon, preschool teachers in various social media tools advertised it for preschool teachers' attention. The survey has also been distributed to the number of participants via direct message who were asked to send the hyperlink to their colleagues, thus creating a snowball effect. The instrument's validity was granted from various field experts ranging from science education, preschool education, environmental education to educational measurement and evaluation.

Data Analysis

The data were analyzed via descriptive statistics because of the nature of the instrument. Most of the data were categorical in nature, so it was impossible to go further with inferential statistics. Instead, nonparametric Chi-square statistics were used in the analysis.

Ethical Approval

This study was approved with the Meeting Date and Number 28.05.2019/35853172-600 by the Social and Human Sciences Ethics Committee of Hacettepe University.

Results

Descriptive Statistics Results

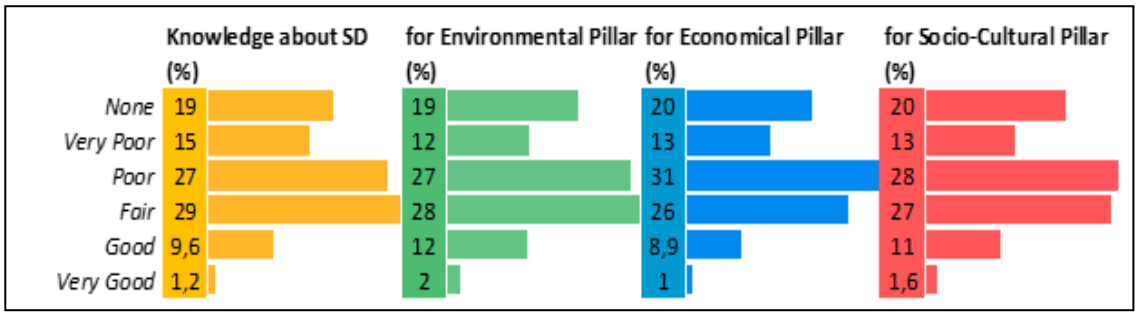
To investigate the teachers' needs for EfS, some questions were asked about their SD knowledge and enrollment in a course/seminar about SD. The first question was that "Have you heard the concept of SD before? If you heard, from where did you hear about the concept of sustainable development?" The results indicated that 362 (32.6%) participants have not heard, but 764 (68.4%) participants reported that they had heard the concept of SD. Most of them stated that they heard the concept of SD from mass media (n=403; 36.2%) and academic publications (n=385; 34.6%). Few of them reported hearing from NGOs (Non-Governmental Organizations) (n=204; 18.3%), undergraduate courses (n=143; 12.9%), and conversations with academics (n=95; 8.5%). The remaining participants stated that they have heard from other sources.

The other question was, "Have you taking any training for EfS?" The analysis revealed that 164 (14.6%) participants reported that they took training for EfS. The places where they took training include undergraduate and postgraduate courses at universities (n=71; 6.4%), NGOs (n=69; 6.2%), MoNE (Ministry of National Education) (n=35; 3.1%), private education institutions (n=23; 2.1%), and TUBITAK (n=20; 1.8%).

We also asked participants, "How would you evaluate your knowledge about SD?" The results showed that participants evaluated their knowledge of SD as poor at 27% and fair at 29%. Examining the bar graph of the results shows that the participants' knowledge about SD is low. In the present study, participants were asked to evaluate their knowledge about the environmental, economic, and socio-cultural pillars of SD. The results showed very similar findings with the level of knowledge about SD. Figure 1 presents the bar graphs of the analyses.

Figure 1

Bar Graphs of the Analyses on the Knowledge about SD and Its Pillars



On the other hand, examining the means and standard deviations of the scores concerning participants' general knowledge on SD and its pillars, it seems that knowledge about the environmental pillar of SD has a higher mean score among the pillars of SD (Table 2).

Table 3

The Means and Standard Deviations of the Scores Concerning Participants' General Knowledge of SD and Its Pillars

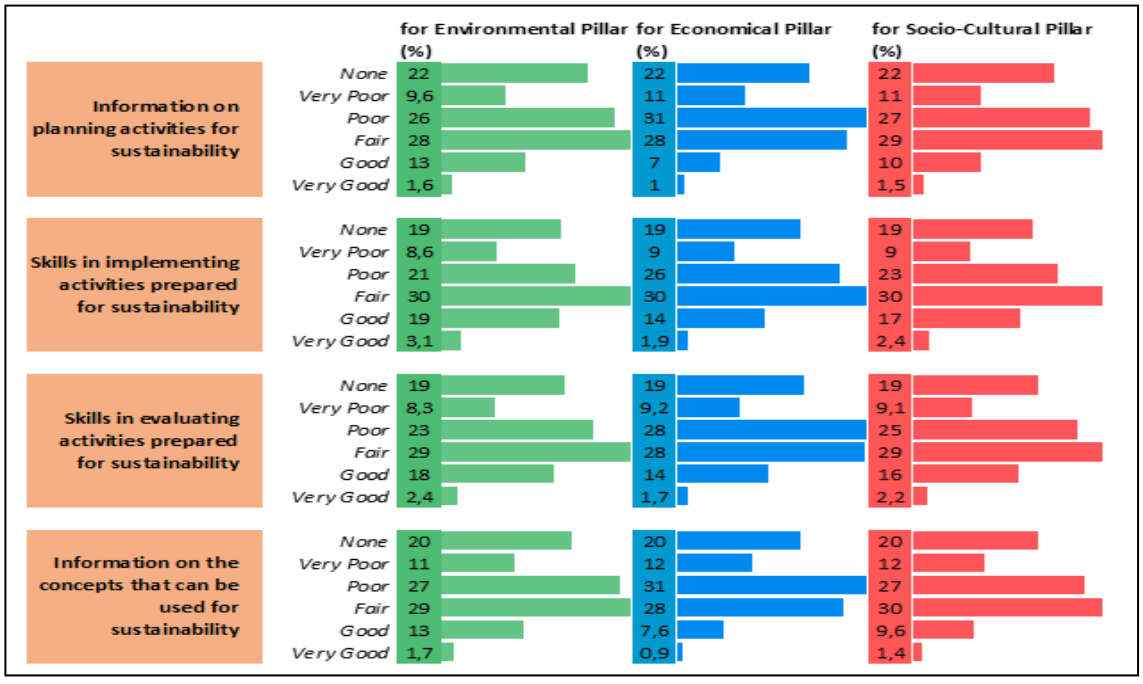
	M	*SD*
Knowledge about SD	1.99	1,31
Knowledge about the environmental pillar of SD	2.07	1.36
Knowledge about the economic pillar of SD	1.94	1.29
Knowledge about the socio-cultural pillar of SD	2.01	1.34

EfS Activities

In this part of the analyses, participants evaluated their knowledge on planning EfS activities, implementing skills, evaluating these EfS activities, and the concepts related to the three pillars of SD. The results indicated that about 22% reported not having any information about planning EfS activities. Furthermore, more than half of the participants reported themselves as "poor" or "fair" in this regard. This finding was found to be similar in all pillars of SD (Figure 2). When the participants' skills in implementing and evaluating EfS activities are examined, it can be seen that approximately 19% of the participants do not have any knowledge of all pillars. As a result of the analysis, it is seen that approximately 53% of them see themselves as poor or fair in implementing and evaluating skills (Figure 2). On the other hand, a small number of participants find themselves competent in these skills. The results also indicated that approximately one-third of the participants reported their knowledge of the concepts related to SD as "fair" and above (Figure 2).

Figure 2

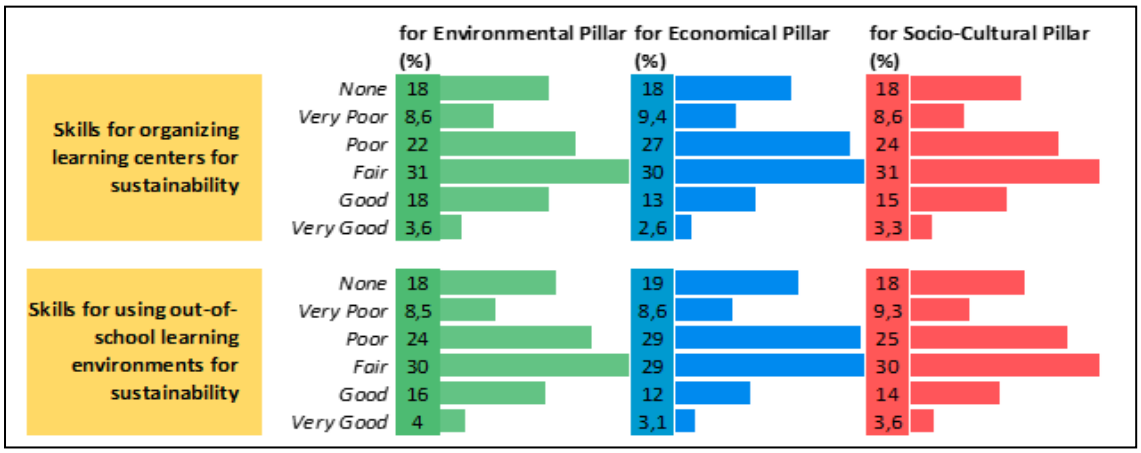
Bar Graphs of the Analyses on Participants' Knowledge on Planning Efs Activities, Skills in Implementing, Skills in Evaluating These EfS Activities, and Information about the Concepts Related to Three Pillars of SD



In this study, participants were asked about evaluating their skills for organizing learning centers or using outdoor learning environments regarding EfS. According to the results, about 18% of the participants found themselves inadequate in these skills, while about 47% reported that they see themselves as "fair" and above proficiency. (Figure 3).

Figure 3

Bar Graphs of the Analyses on Participants' Skills for Organizing Learning Centers and Outdoor Learning Environments

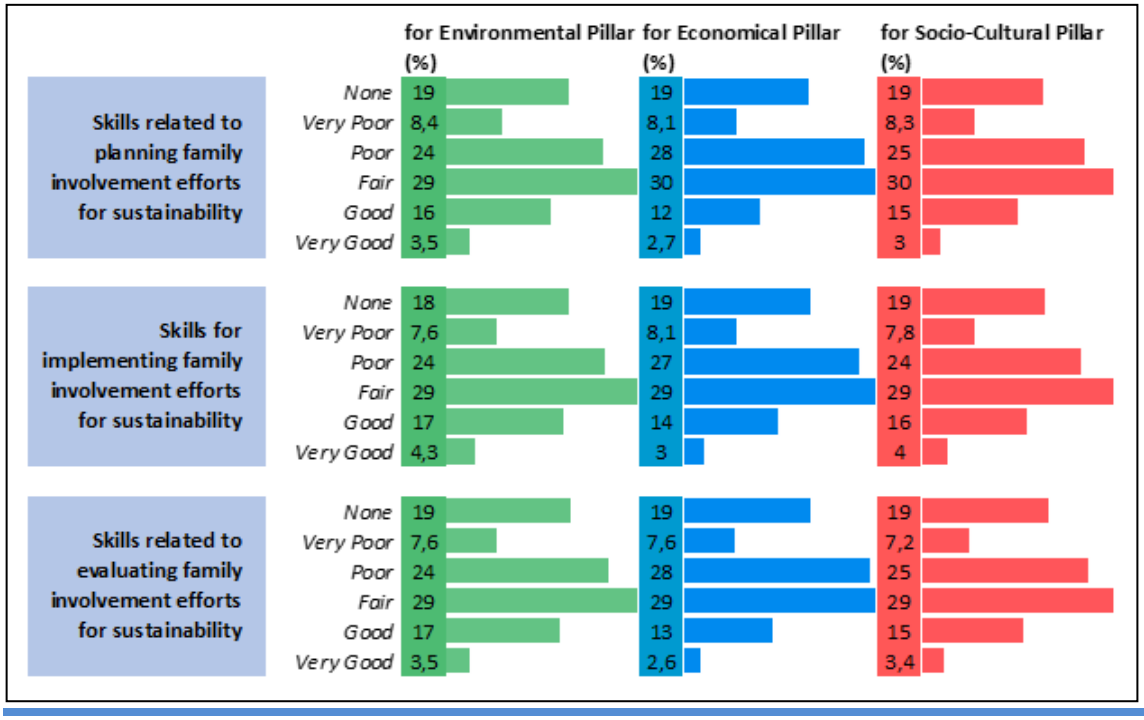


Family Involvement

Another issue was participants' skills on family involvement for SD. According to the results, only less than 20% of the participants consider themselves competent regarding family involvement. Moreover, 19% of them stated that they do not have any skills. Figure 4 represents some graphs to show the findings of family involvement.

Figure 4

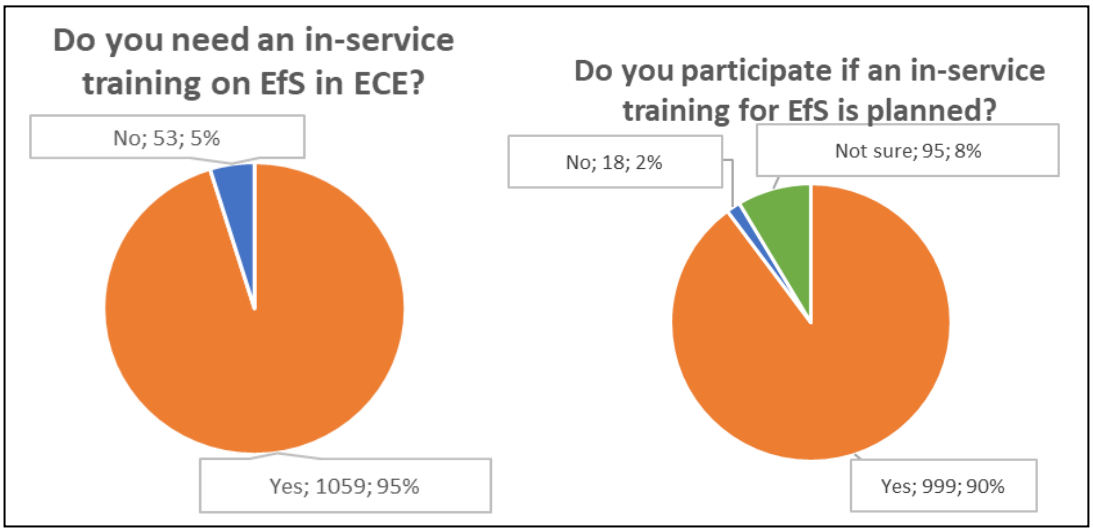
Bar Graphs of the Analyses on the Knowledge about SD and Its Pillars



In the present study, the participants answered two additional questions about in-service training on taking EfS. As a result, almost all participants stated that they needed in-service training on EfS (n=1068; 94.8%), and most of the participants (90.0%) also stated that they would enroll in in-service training for EfS (Figure 5).

Figure 5

Bar Graphs of the Analyses on the Knowledge about SD and Its Pillars



Chi-Square Test Results

The study's last findings were related to whether participants' answers on hearing SD before differing regarding the types of schools they worked in. The chi-square for independence was run after checking the assumptions for it such as minimum expected cell frequency. The test results firstly indicated that this assumption was not violated and all expected cell sizes are greater than 5 (43.15). The results also revealed that relation between these variables was significant, $X^2(1, N=1125)=13.131$, $p<.01$. It means that participants' answers have significantly differed concerning the schools' type that they were working. It is observed that a higher proportion of participants in private schools have heard of SD compared to public schools (Table 4).

Table 4

The Number of Participants' Hearing SD and the Type of Schools That Participants Were Working in

	Have you heard the concept of SD before?	
	Yes	No
Public	*n*=538(64.90%)	*n*=291(35.10%)
Private	*n*=226(76.35%)	*n*=70(23.65%)

Discussion and Conclusion

Children are regarded as individuals who hold the skills to participate in problem-solving and decision-making processes of recent environmental, social-

cultural, and economic issues. These changing perspectives towards children made them active agents for change to be involved in activities related to SD (Davis, 2010; Duhn, 2012; UNESCO, 2008;). Preschool teachers are seen as essential dynamics to promote SD in societies starting from the early years (Henderson & Tilbury, 2004; Kahriman Pamuk & Olgan, 2020). Today's preschool teachers need to understand better the theory and practices of EfS to make connections between children and the sustainable world. In this regard, the current study aims to grasp preschool teachers' general knowledge on SD and its pillars, their experience in preparing and implementing EfS activities, and their PD needs for EfS as a first stage of developing PD modules.

According to the present study's initial findings, but 68.4% of them have heard the concept of SD before, 32.6% of preschool teachers have not heard the concept of SD. These findings revealed that most of the preschool teachers acknowledge the term SD. Preschool teachers also reported that they heard about SD mainly by mass media (36.2%) and academic publications (34.6). Other critical resources were defined as NGOs (18.3%), undergraduate courses (12.9%), and conversations with academics (8.5%). Similarly, 68% of the Korean preschool teachers reported that they heard about SD, and they indicated workshops and seminars (28 %), mass media sources (19%), and academic publications (19%) as the primary source for this (Park et al., 2016).

When comparing with the findings of previous studies, it may be concluded that SD is an emerging issue in Turkish early childhood education. Indeed, Haktanır et al. (2010) reported that pre-school teachers and pre-service preschool teachers did not know about the concepts of sustainability and SD ten years ago. Although SD is becoming more popular in early childhood education and preschool teachers reported that they believe in the importance of SD for the future, the whole meaning and underpinned ideas were not comprehended (Kahriman Öztürk & Olgan, 2016). Hedefalk et al. (2015) also highlighted the limited comprehension of preschool teachers about SD. Researchers reported that preschool teachers perceive SD with only the environmental pillar. Similarly, Inoue et al. (2016) concluded that though the Australian early childhood curriculum covers the issues of SD, the teachers do not have enough information and practices about EfS. Researchers suggested that in-service training opportunities related to EfS could be provided to teachers to promote sustainability-related understandings and practices.

Like the relevant literature, the current study also exhibits limited SD knowledge of preschool teachers. According to the findings, participants evaluated their knowledge of SD as poor at 27% and fair at 29%. It means that their level of knowledge is considered low. Examining the findings related to SD's pillars, participants evaluated their knowledge about the environmental, economic, and socio-cultural pillars of SD as low too. As mentioned above, preschool teachers' knowledge about SD is critical since they are responsible for introducing SD to children (World Commission on Environment and Development [WCED], 1987). Flogaitis and Agelidou (2003) and Bursjöö (2011) added that preschool teachers consider the lack of SD knowledge as a barrier to implementing EfS activities. Therefore, limited SD knowledge is one of the reported barriers to applying EfS the preschool classrooms. In connection with this argument from relevant literature, participants of the current study also evaluated their knowledge on planning EfS activities and skills in implementing and evaluating these EfS activities for three pillars of SD as poor or fair. Kahriman Pamuk and Olgan (2018)

defined EfS activities as in-class and outdoor learning processes run by preschool teachers with children's participation to promote SD.

There is a worldwide attempt to promote teachers' sustainability-related understandings and practices. Reorienting education programs towards SD could be a way of encompassing teachers' roles in EfS (Sterling & Huckle, 2014). In this regard, they must understand how teachers perceive SD and what they need to associate EfS into the existing curriculum. The national preschool education program (MoNE, 2013) implicitly refers to SD via its objectives and indicators. For example, "respect for diversity," "reflect on different cultural features," and "maintain aesthetic values" are appropriate objectives that are also critical features for sustainability. However, the current study's findings also revealed that preschool teachers do not know SD-related concepts in the national preschool education curriculum.

Similarly, regarding the implementation of EfS activities, participants were examined about their knowledge on the concepts related to SD, skills for organizing learning centers, and outdoor learning environments. Organizing learning centers and using outdoor learning environments regarding EfS were seen as challenging tasks for the participants. About one-fifth of them do not know how to organize learning centers and use outdoor learning environments. Furthermore, half of them do not trust enough their skills to do these tasks. This result is not surprising since most participants noted that they had poor and fair knowledge about SD. In these circumstances, teachers could not create learning centers and use outdoor environments in the face of EfS and SD. This might be directly linked to teachers' conceptions of EfS to be limited (Dyment et al., 2015), teachers' value, and a lack of awareness of the priority of EfS (Nicholls & Thorne, 2017).

On the other hand, according to teachers, they do not have enough resources to pick up materials for the learning centers independently of SD and EfS in Turkey (Demirci & Şıvgın, 2017; Özyürek & Kılınç, 2015). Therefore, teachers might not search how to organize, what materials use and how to use them for EfS. However, according to Prescott (1987), a well-organized environment encourages children to follow themselves or their curiosity. Besides, the environment affects how children move, behave, and it also determines how, what and where children will play (Hoorn et al., 1993). Moreover, it offers an educational experience and a visual representation of the value of school or teacher values (Barr et al., 2014).

Furthermore, teachers reported they did not have sufficient skills to organize learning centers and outdoors for EfS in the present study. On the other hand, according to Davis (2010), the outdoor environment is a learning setting and a resource for children. Therefore, they need exposure to sustainable lifestyle practices to foster their capacities (Ginsburg & Audley, 2020). Furthermore, Kahriman Pamuk and Olgan (2018) addressed that eco and ordinary preschools had different physical conditions, but there was no significant difference in their classroom practices. Thus, organizing the environment might be related to teachers' attitudes towards safety, nature, and place (Padilla-Walker & Nelson, 2012). Otherwise, the physical environment influences how teachers think and practice implementing EfS practices (Henderson & Tilbury, 2004). Thus, it is imperative to figure out their pedagogical practices regarding EfS (Ginsburg & Audley, 2020) and guide them to improve their skills, knowledge, ideas, and practices about EfS to organize and use the indoor and outdoor learning settings.

Family involvement was another critical issue for this study. According to the results, one-fifth of them consider themselves competent regarding family involvement efforts for SD. Moreover, 19% of them stated that they do not have any skills for all SD pillars. The dynamics of the family impact the transition of children's behaviors and knowledge to the home (Lee et al., 2019) because children might have the agency to adjust both at school and home (Ginsburg & Audley, 2020). According to Bandura (1986), parents are a social context for children's learning. Borg (2019) stated that parents are sources of knowledge for children to learn other children's economic situations. Educators recognized that more powerful messages could be delivered when parents participated in children's sustainability awareness (Morris et al., 2016). Güler Yıldız et al. (2017) found that children's behaviors were shaped in terms of doing activities at home because the skills about EfS ought to be part of their daily lives (Renton & Butcher, 2010). Therefore, teachers might support, lead and educate parents about SD (Güler Yıldız et al., 2017). Hence, skills and knowledge about planning, implementing, and evaluating parent involvement activities are critical for cooperating to lead children about SD and EfS. On the other hand, parental beliefs about the outdoors associate with risk (Knight, 2013; Michek et al., 2015), so it is a barrier to EfS. Therefore, family involvement is critical especially using the outdoor environment as a resource. In the present study, most of the teachers have poor or fair skills for planning, implementing, and evaluating the family involvement activities about the three pillars of SD. This might be linked to knowledge and skills for planning EfS activities and about 22% reported that they did not have any information about planning EfS activities. Therefore, teachers need to know how to do these. This process is vital considering not only for children, but also for society (Davis et al., 2008; McNichol et al., 2011).

The school type could be seen as a significant part of gaining awareness for SD. The last findings were related to whether participants' answers on hearing SD before differing regarding the types of schools they worked in. The results indicated that participants' answers differed concerning the type of school they were working at. It is observed that a higher proportion of participants in private schools heard of SD compared to public schools. This finding was also reported by Korkmaz and Güler Yıldız (2017) that there was a difference between public and private Eco-Schools regarding EfS practices in favor of private Eco-Schools. Teachers working in private schools were more competent for the environmental pillar of SD, but they were the same within the socio-cultural pillar. A possible explanation might be that SD activities generally contribute to the environmental pillar (Korkmaz & Güler Yıldız, 2017).

Consequently, there is a widespread bolster for EfS, but it is still challenging for planning and implementation in preschool classrooms. As expected, almost all participants stated their needs for in-service training on EfS and their willingness to participate. This study's findings revealed that a small portion of participants took training on EfS throughout undergraduate and postgraduate courses at universities, NGOs, MoNE, private education institutions, and TUBITAK. Kahriman Öztürk and Olgan (2016) reported the need for in-service training on EfS. Similarly, Inoue et al. (2016) highlighted that EfS related in-service training such as courses, lessons, seminars, and so on would positively affect preschool teachers' views about EfS.

Limitations

The reader should bear in mind that the study is based on preschool teachers' self-report to determine their needs about EfS as a first step for developing a PD. Establishing how teachers plan their activities, how activities are implemented, and how children use learning centers and outdoor environments are beyond the current study's scope. Therefore, addressing them may provide more valid information on this issue for future studies. Also, it might exhibit the pedagogical content knowledge of teachers. Secondly, it is beyond the current study's scope to explore what teachers know about EfS and how they translate knowledge into practice in the classroom. Exploring these processes might be helpful to guide teachers in improving their practices. Thirdly, some teachers reported that they have good and excellent knowledge and skills on planning, implementing, and evaluating SD activities for both children and family involvement, organizing learning centers, and using outdoor environments. Information on how they execute these was not the focus of this study. Future research might reveal these so teachers could see the best practices. Despite its limitations, the study certainly adds to what teachers say their knowledge and skills about SD and EfS activities regarding SD pillars.

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Statement of Responsibility

All authors have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this manuscript has not been and will not be submitted to or published in any other publication before its appearance in the Journal of Theoretical Science.

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Investigating the Change in Middle School Students' Mathematical Modeling Competencies according to Their Reading Comprehension Skills Levels*

Ortaokul Öğrencilerinin Okuduğunu Anlama Becerisi Düzeylerine Göre Matematiksel Modelleme Yeterliklerindeki Değişimin İncelenmesi

Yasemin ALKAN** **Mehmet AYDIN*****

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ABSTRACT: In this study, how the learning process designed with mathematical modeling activities affects the mathematical modeling competencies of middle school students who are at different levels in terms of reading comprehension skills. In the study, nested (embedded) pattern was preferred among mixed method research designs. The participants of the study consisted of 26 middle school seventh grade students who were selected using the easily accessible situation sampling method, which is one of the purposeful sampling types. In the research, besides mathematical modeling activities, researcher and student diaries were used to obtain qualitative data on the functioning of the application process. "Modeling Activities Opinion Form" was also used at the end of the application process in order to determine the general views of the study group on the activities. The quantitative data of the study were collected through the "Reading Comprehension Test" and "Mathematical Modeling Competence Test", and the collected data were analyzed using both qualitative and quantitative data analysis methods. At the end of the study, it was determined that the mathematical modeling competencies of the students improved, but this development did not follow a stable course during the application process and the interpretation and validation competencies of the students were low.

Keywords: Mathematical modeling competence, reading comprehension skill, mathematical modeling activities.

ÖZ: Bu araştırmada, matematiksel modelleme etkinlikleri ile tasarlanan öğrenme sürecinin, okuduğunu anlama becerisi açısından farklı düzeylerde bulunan ortaokul öğrencilerinin matematiksel modelleme yeterliklerini nasıl etkilediği incelenmiştir. Çalışmada, karma yöntem araştırma desenlerinden iç içe (gömülü) desen tercih edilmiştir. Araştırmanın katılımcıları, amaçlı örnekleme türlerinden olan kolay ulaşılabilir durum örneklemesi yöntemiyle seçilen 26 ortaokul yedinci sınıf öğrencisinden oluşmaktadır. Araştırmada, matematiksel modelleme etkinliklerinin yanı sıra; uygulama sürecinin işleyişine dair nitel veriler elde etmek amacıyla araştırmacı ve öğrenci günlüklerinden yararlanılmıştır. Çalışma grubunun etkinlikler ile ilgili genel görüşlerini belirlemek amacıyla uygulama süreci sonunda ayrıca, "Modelleme Etkinlikleri Görüş Formu" kullanılmıştır. Araştırmanın nicel verileri ise, "Okuduğunu Anlama Becerisi Testi" ve "Matematiksel Modelleme Yeterliği Testi" aracılığı ile toplanmış, toplanan veriler nitel ve nicel veri analizi yöntemleri birlikte kullanılarak analiz edilmiştir. Çalışmanın sonunda, öğrencilerin matematiksel modelleme yeterliklerinin geliştiği ancak bu gelişimin uygulama süreci boyunca istikrarlı bir seyir izlemediği ve öğrencilerin özellikle yorumlama ve doğrulama yeterliklerinin düşük olduğu belirlenmiştir.

Anahtar kelimeler: Matematiksel modelleme yeterliği, okuduğunu anlama becerisi, matematiksel modelleme etkinlikleri.

* This study is part of the master thesis entitled "Investigating the Change in Middle School Students' Mathematical Modeling Competencies According to Their Reading Comprehension Skills Levels" by first author conducted in supervisor of second author.

** *Corresponding Author*: Mathematics Teacher, Silvan Gökçetevek Middle School, Diyarbakır, Turkey, yasemin.alkan0301@gmail.com, https://orcid.org/0000-0001-9176-9218
*** Asst. Prof. Dr., Dicle University, Ziya Gökalp Faculty of Education, Diyarbakır, Turkey, mehmet.aydin@dicle.edu.tr, https://orcid.org/0000-0002-0718-8662

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Mathematical modeling is the process of analyzing a real-life situation by using mathematical methods (Erbaş et al., 2014). Mathematical modeling, which includes the processes of transforming a real-life problem into a mathematical problem, generating mathematical solutions, and then interpreting these mathematical solutions in a real context (Blum & Leiß, 2007; Borromeo Ferri, 2006; Lesh & Doerr, 2003), has an important role in generating solutions from a perspective. Although there are various definitions for Mathematical Modeling in the literature, it is seen that it is considered as a process. According to Borromeo Ferri (2006), who defines mathematical modeling as a six-step process, the first step of this process is a complete and correct understanding of the problem situation by the problem solver. The ability to create models by performing these six steps properly and to analyze or compare the given models is defined as "Modeling Competence" (Blum & Borromeo Ferri, 2009). Another definition for mathematical modeling competence was made by Kaiser and Maaβ (2007). According to them, mathematical modeling competence is to complete the mathematical modeling process willingly and purposefully. Studies have shown that mathematical modeling improves students' thinking skills, increases their academic achievement and their level of associating mathematics with daily life, and improves a positive attitude towards mathematics (Brown & Stillman, 2017; Çiltaş & Işık, 2012; Doruk, 2010; Kaiser & Schwarz, 2006; Sandalcı, 2013). Considering the general objectives of our country's Elementary Mathematics Course Teaching Program, it is seen that competencies are aimed to be improved such as students' mathematical literacy, understanding and using mathematical concepts, predicting, mental processing, research making, knowledge generation, self-confident attitude towards mathematical problems, expressing mathematical thoughts, reasoning and relating (Ministry of National Education [MoNE], 2018). These general objectives in the program are among the competencies that can be acquired by students through mathematical modeling (Blum & Borromeo Ferri, 2009; Hıdıroğlu, 2015; Lesh & Doerr, 2003). In many western countries, curriculum reforms, especially at secondary education level, consider mathematical modeling as an important element in current secondary education mathematics programs that prepare students for further education (Blomhøj, 2009). Modeling is of great importance for the present and future lives of students and is an important part of NCTM (National Council of Teachers of Mathematics) principles and standards for school mathematics. It is important for students to learn how to solve modeling problems (Schukajlow et al., 2015).

The first step in solving a mathematics problem is to understand the problem in question. The success of students in reading comprehension skills forms the basis of their success in other courses (Bloom, 1995; Ural & Ülper, 2013). Studies have shown that reading comprehension is directly related to science achievement (O'Reilly & McNamara, 2007) and mathematics achievement (Walker et al., 2008), and directly affects students' achievement in other courses (O'Reilly & McNamara, 2007; Özçelik, 2011; Uzun, 2010; Vilenius-Tuohimaa et al., 2008). All these results show that students' reading comprehension skills can also affect their mathematical modeling competencies in particular.

When looking at the historical development of the studies on mathematical modeling, it is seen that Pollak (1969) defined mathematical modeling as real-life applications of mathematics. It can be said that the real-life problems that Pollak

discussed as mathematical applications in this study were addressed as problem solving, modeling and mathematical modeling in the 1980s (Kapur, 1982). Modeling studies, which have increased since this date and express real-life mathematical applications and real-life problems mostly as mathematical modeling (e.g., Blum & Niss, 1991; Pollak, 1997), have started to be handled in different dimensions in the 21st century. For example, while different mathematical modeling approaches and the modeling definitions of these approaches are dealt with epistemologically in some studies (Kaiser & Sriraman, 2006), some studies have focused on the steps, components and cognitive features that emerge in the mathematical modeling process, which is a common acceptance of different approaches (e.g., Borromeo Ferri, 2006; Şen-Zeytun, 2013). Researchers, who see mathematical modeling as a competence that should be taught, have carried out studies to determine and develop mathematical modeling competencies (e.g., Kaiser, 2007; Tekin-Dede, 2015). On the other hand, since mathematical modeling activities differ from conventional teaching methods (Lesh & Doerr, 2003), some studies examine students' views and beliefs about mathematical modeling (Kaiser & Maaß, 2007), while some studies examine the relationships between students' modeling competencies and grade level and mathematics achievement. (Tekin-Dede, 2017). Some studies have also examined how individuals construct mathematical knowledge through mathematical modeling by evaluating modeling in the teaching dimension (Hitt & González-Martín, 2015; Lesh & Carmona, 2003).

On the other hand, there are studies in which, such as mathematical modeling, reading comprehension skill is associated with variables such as mathematical reasoning (Erdem, 2016), mathematics achievement (Özdemir & Sertsöz, 2006), or mathematical performance (Lerkkanen et al., 2005). However, as stated by Ural and Ülper (2013), there are only limited number of studies focusing on the relationship between mathematical modeling competence and reading comprehension skill.

Albayrak and Çiltaş (2017) determined that 71.1% of the articles and 53.6% of the theses were conducted with qualitative approaches and mainly using the case study method in the content analysis of 38 articles published in 24 national journals and 28 theses published in 14 different institutes in Turkey on mathematical model and modeling. In addition, they stated that there are a limited number of experimental studies in Turkey on mathematical model and modeling, which are mostly carried out with undergraduate students, and in these studies, how learning occurs with mathematical modeling is not explained in detail. They emphasize that it is necessary to go beyond the standard research designs used and to use more research designs that have not been used or rarely used until today, rather than at the undergraduate level. Due to the importance of mathematical modeling that enables students to perform a learning process in which they are active and intertwined with daily life, it is understood that the use of mathematical modeling in classroom environments should be widespread and research on mathematical modeling should be diversified. Considering the approaches, methods and samples used in previous studies, the lack of a satisfactory number of studies conducted with secondary school students, especially including qualitative findings, and examining the possible relationships between mathematical modeling competencies and reading comprehension skills during an experimental process, lead the researchers to the current study. In this study, mathematical modeling competencies of middle school seventh grade students who have different levels in

terms of reading comprehension skills were followed through an experimental process to determine the change or development in these competencies. Therefore, it is thought that the results to be obtained will contribute to the relevant literature and the planning of learning environments to be organized for mathematics teaching.

The Relationship between Mathematical Modeling and Reading Comprehension

In order to solve a math problem, it is necessary to understand the problem correctly. As stated by Krawitz et al. (2017), in mathematical modeling problems, it is clear that reading comprehension is a necessary condition for deriving a situation model from the text, since a real-world situation is often presented in writing, and reading comprehension plays an important role in understanding and further structuring and simplifying the written information presented about the real-world situation. Schmelzer and Schukajlow (2017) also stated that in order to solve a mathematical modeling problem, a superficial combination of numbers given in the problem is not sufficient, and first of all, an in-depth understanding is needed. Based on these expressions, it can be said that students should be able to understand what they read in order to solve problems. According to Yantır (2011), the skills of individuals who do not have the ability to understand what they read, such as understanding, expressing, generating thought, interpreting, analyzing, criticizing, and communicating, are not sufficiently developed. When students encounter a problem, they sometimes try to solve the problem by using the methods they know by heart without fully understanding the problem (Gökkurt et al., 2015). It is clear that the solutions made in this way will not make enough contribution to the learning and mental development of students. For this reason, it can be said that understanding the problem is a prerequisite for problem solving. Whether or not students understand a problem correctly can be understood from stages such as separating the given and desired items, creating a diagram suitable for the problem, and drawing a shape in the process of solving a mathematical problem (Çiftçi et al., 2018). According to Baykul (1995), in order for students to understand a problem, they should express the problem in their own words after reading the problem and write down what is given and requested in the problem.

These statements, which show that reading comprehension skill has an effect on skills such as comprehension, analysis, and interpretation, show that there is a close relationship between mathematical modeling and reading comprehension skill. In the literature, there are studies in which mathematical modeling is associated with reading comprehension (Krawitz et al., 2017; Plath & Leiss, 2018; Ural & Ülper, 2013). However, there are not many studies in which reading comprehension is associated with all the sub-steps of mathematical modeling and this relationship is evaluated by using quantitative and qualitative data together during a teaching process. In this respect, this study seems to be important in terms of revealing the relationship between reading comprehension skills and mathematical modeling skills, which constitute a great basis for the efficient education of students.

In the study, it was aimed to examine the effect of the learning process designed with mathematical modeling activities on the mathematical modeling competencies of the seventh-grade middle school students who have different levels in terms of reading comprehension skills.

In line with this stated purpose, answers were sought for the following sub-problems:

1. What is the relationship between students' reading comprehension skills and their mathematical modeling competencies?
2. How do students' mathematical modeling competencies change during the application process?

Method

Research Model

In this study, embedded mixed design was preferred among one of the mixed method research designs. In embedded mixed design, quantitative or qualitative data are placed in a wider pattern, and these data sources have a supportive role in the whole pattern (Creswell, 2016). The most common example of embedded mixed design is the pattern that emerged when the researcher included qualitative data into the experimental process (Creswell & Plano Clark, 2018). In this study, an experimental process was carried out using mathematical modeling activities. The qualitative findings obtained by observing the students' mathematical modeling competencies in the process and taking their opinions were supported by quantitative findings. The research was designed in four steps: pre-application, application process, post-application and interpretation of the data. In this way, it aimed to determine the changes in the students' mathematical modeling competencies before, after, and during the application. The research process, which was designed in four steps, is presented in detail under the title of "main application process".

Participants

The participants of the research consist of 26 middle school seventh grade students studying in a village school in a district of Diyarbakır in the academic year of 2018-2019. The study group in question is the students who took the "Elective Mathematics Applications Course" at the researcher's school. For the study group, the seventh and eighth grade levels of secondary school were found more appropriate in terms of understanding the activities, communication between students, directing students, and ease of implementation. However, it was thought that students studying in the eighth grade would not be able to express their own mental processes fully, skills and opinions during the research process, especially since their preparation process for the Transition Exam to High Schools (TEHS) in the second term was stressful, so it was decided to work with seventh grade students. In addition, it is thought that the contributions to be provided by this application process, which is carried out with modeling activities, will provide benefits to the participant students for the TEHS that they will enter in the next year. The researcher chose class A among the three seventh-grade classes (A, B, and C) because of the factors such as the stable school attendance of the students in this class, their openness to new methods in teaching, and their more positive attitude towards the course. The participants consist of 16 girls and 10 boys. Students are labeled as S1, S2, S3, … S26 in codes from 1 to 26. The students in the participant group come from families who live in rural areas, generally earn their living from agriculture and animal husbandry, have a low or middle income, and the highest education level is high school graduates.

Data Collection Tools

The Mathematical Modeling Competence Test consists of three mathematical modeling problems prepared by the researcher to be used as the pre modeling competence test (Pre-MMCT) and the post modeling competence test (Post-MMCT). Each of the "Knowledge Contest", "Sleep Time" and "Book Reading" problems in the test was created by examining the problems in the related literature and mathematics applications textbooks and based on the situations that students may encounter in their daily lives. Since the relationship between mathematical modeling competencies and reading comprehension skills was investigated in the study, modeling activities were not developed for a specific subject but by taking into account the objectives of different subjects. In addition, in order to reveal the mathematical modeling competence levels of the students, some sub-questions that could be instructive for the student were created with the given problem. The questions were formed with two researchers working in a similar subject area and the questions were finalized by taking the opinions of two experts. These questions are presented below:

1. Express the problem in your own words.
2. Explain what information you need to solve the problem.
3. Explain mathematically how you will go for the solution of the problem.
4. Take appropriate actions for the solution of the problem.
5. How can you interpret your solution in relation to real life? Explain.
6. How can you be sure that your result is correct? Explain.

In pilot applications, the "Knowledge Contest" problem was applied to 25 students studying at the 7th grade level, the "Sleep Time" problem to 23 students, and the "Reading Book" problem to 24 students. With the pilot study, necessary arrangements were made in the areas that are not understood in subjects such as the implementation period of the activities, the suitability and adequacy of the materials used, the difficulties encountered in the application, and the language-expression of the problems. For example, in the pilot implementation, it was decided to give 50 minutes to each problem, taking into account the students' problem-solving time and student opinions. The problems were finalized in line with the opinions of two field experts.

Reading Comprehension Skills Test is a multiple-choice achievement test consisting of 30 questions developed by Sert (2010) for 6th grade students and used to measure students' reading comprehension skills. Validity and reliability study was conducted on 110 students by the same researcher. In this study, due to the small size of the sample group in which the test was applied, the KR 20 reliability value of the test was found to be .59 as a result of the statistics. This result is at a moderate level for the reliability of the test (Hinton et al., 2004), showing that the test is reasonably reliable in measuring reading comprehension skills. Although this achievement test was developed for 6th grade students, it was also used at the 7th grade by Kaçar (2015). In this study, the purpose of selecting this test to measure students' reading comprehension skills is to consider that it is suitable for the study group students' levels. In addition, this achievement test was presented to the opinion of a teacher who attended the Turkish lesson at the school where the study group was educated, and it was decided that it was suitable for the levels of the study group students and the objectives of the subject that they expected to acquire.

Mathematical Modeling Activities consists of 7 mathematical modeling activities prepared to be used in the application process of the research. Football League, Bekir's Birthday Party, Mystery of Unit Cubes, Cinema Hall, Electricity Saving and Rainfall activities were prepared by the researcher, and Oil Spill activity was taken among Programme for International Student Assessment (PISA) in 2012 pilot application questions, considering that it is appropriate for the students' level. Each of the activities was presented to the opinion of two experts in the field and two researchers working in the same field, and the activities were finalized in line with the opinions received. In these activities, in order to reveal the mathematical modeling competencies of the students, similar instructions and activity development procedures were used which are also used in Pre-MMCT and Post-MMCT. Football League and Bekir's Birthday Party activities were applied to the students individually and it was observed that the students had difficulties in the activities. Because of this, the Mystery of Unit Cubes, Cinema Hall, Electricity Saving and Oil Spill activities were applied to the students in groups, both in terms of the convenience they provide and to make the activities more enjoyable for the students. The groups were formed with five for two of them and four for four. The last activity, the amount of rainfall activity, was applied to the students individually in order to see the competencies of each of the students in their modeling competencies more clearly.

Below is an example of one of the activities used in the implementation process:

Figure 1

(Sample Activity): *Electricity Saving*

ELECTRICITY SAVING

According to statistics, per capita consumption is 3082 kwh of electricity in Turkey in 2017 with 80.81 million population.

According to this, "If each family in the country saves the light of each room in their home for 1 hour, what kind of a reference will be the amount of electricity consumption per individual per year? How can you explain the contribution of this situation to the economy of your country?"

(1 bulb consumes about 10 watts of energy per hour.1 kwh = 1000 watts)

The researcher prepared Modeling Activities Opinion Form to get the study group's general views on mathematical modeling activities at the end of the process. This form consists of 6 open-ended questions such as "Did you have difficulty in doing the activities? Which activity did you have the most difficulty in? Explain with the reasons", "How are these activities different from the math problems you generally encounter? Please, explain", "Do you think there is a relationship between these activities and reading comprehension?". A pool of questions was created using the relevant literature and six questions were selected among these questions that could be adapted to the sub-problems of the research. After the questions were made suitable for the purpose of the research, they were presented to the opinion of two field experts. After the necessary parts were changed, the final form was given to the opinion form.

The purpose of using the opinion form in this study is to support the findings by determining the general views of the students about the activities. Thus, it is aimed to make the study more comprehensive by obtaining more detailed data about the contributions of the applied activities to students.

The Researcher and Student Diaries were used to record the details of the implementation of each activity throughout the implementation process. The aim of the researcher diaries is to reveal the mathematical modeling competency processes that students could not reveal on their activity papers. For example, it may not always be obvious from the activity sheet whether the student verified, checked the found solution, and corrected it if there is a mistake. It is more appropriate for the researcher to observe the students during the activity and instantly note the places that is considered as important in terms of the reliability of the results. Student diaries, on the other hand, were used to provide data about the student's views and opinions about that activity after each activity.

Data Analysis

In the research, the maximum score that can be obtained from the reading comprehension test was determined as 30, and the students' reading comprehension test scores were evaluated by giving 1 point for each correct question. *Modeling Competencies Evaluation Rubric* was used to score the mathematical modeling competencies of the students. Modeling Competencies Evaluation Rubric was developed by Tekin-Dede and Bukova-Güzel (2014). In the rubric, the mathematical modeling competencies were evaluated in six steps: understanding the problem (UP), simplification (SI), mathematization (MA), working mathematically (WM), interpretation (IN) and verification (VE). In this study, the minimum score for each level was determined as "0" and the maximum score as "12". For example, Level 1 corresponds to "0 points", Level 2 to "4 points", Level 3 to "8 points", and Level 4 to "12 points" in the simplification step evaluated at 4 levels.

In the first sub-problem of the study, Pearson Correlation Coefficient was used to understand whether there is a meaningful relationship between reading comprehension skill and mathematical modeling competence by using simple correlation technique. When analyzing the relationship between the reading comprehension skill and the scores obtained according to each sub-step of mathematical modeling, the "Pearson Correlation Coefficient" was used for the steps in which the scores were normally distributed, and the "Spearman Correlation Coefficient" was used for the steps where the scores were not normally distributed. The qualitative data obtained from student activity papers, diaries and opinion forms were analyzed descriptively with a qualitative approach.

In order to find an answer to the second sub-problem of the study, the modeling competencies of the students in the application process were examined according to their reading comprehension skills and compared by means of column charts. Students' modeling efficacy scores for each activity were determined again through Modeling Competencies Evaluation Rubric. The students were divided into three different levels of reading comprehension using the frequency table created by the researcher using the scores obtained from the reading comprehension test. The frequency table of students' reading comprehension levels is given below:

Table 1

Frequency Table of Reading Comprehension Levels

Reading Comprehension Skill	Score Range	Number of Students
Level 1	12-17	4
Level 2	18-23	16
Level 3	24-29	6

While creating the frequency table, firstly, the range of the group was found by taking the difference of the highest score and the lowest score from the test. In order to make it easier to compare with column charts, the number of classes was determined as three, and the class width was found by dividing the range by the number of classes. Score ranges have been established according to the determined class size, and each student is divided into levels according to the received score. The modeling score averages taken from each activity were considered separately for students at each level. In this way, in terms of reading comprehension skills for each activity, the mean scores of mathematical modeling efficacy of level 1, level 2 and level 3 students were determined and compared by means of column charts. In addition, the ideas and thoughts of the students regarding each activity were recorded daily through the student diaries throughout the process, and direct quotations were made from these collected data in some parts of the study. The whole process was observed by the researcher and notes were taken about the important parts. Since it is sometimes not understood from the student papers whether the students have verified the solution that they have obtained and corrected the parts that they found wrong, the taken notes were used to understand whether the students performed the "Verification" step, especially of mathematical modeling. In addition, the taken notes by the researcher were used to understand that in which stages of the activities and why they had difficulties. Proximity to the research area, collecting information directly and in the environment of the event through observations, and the ability to go back to the field to confirm the findings and having opportunity to collect additional information are important features in terms of the validity of qualitative data in a study (Yıldırım & Şimşek, 2016).

Ethical Procedures

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee. Before the research started, the researcher applied the institutional ethics committee for ethical approval. The ethical committee approval date is November 15, 2018 and the number of the approval document is 111572.

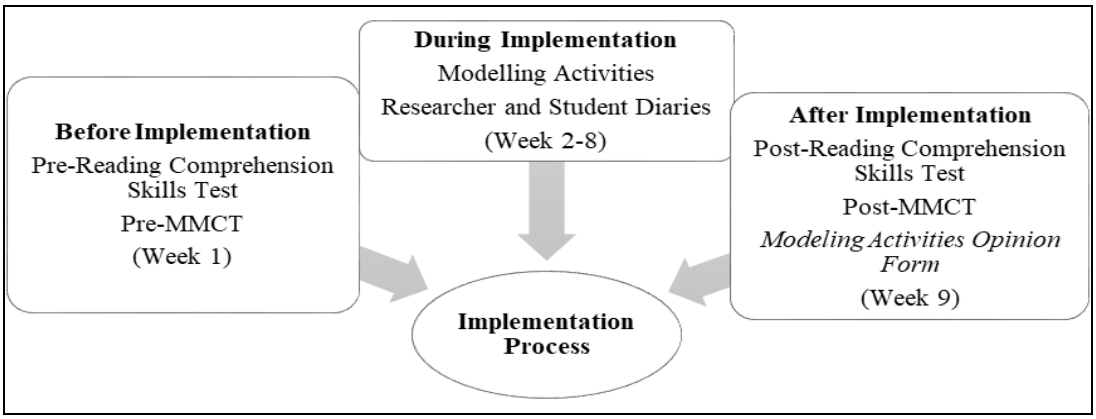
Main Implementation Process

The research was carried out in a total of 9 weeks, including the 7-week modeling activities implementation process (MAIP) and the one-week implementation of the pre-test and post-tests. Before the seven-week MAIP, quantitative data on students' modeling competencies and reading comprehension skills were collected through pre-tests. Later, MAIP was started and qualitative data were collected using researcher and student diaries to reveal the students' modeling competencies in detail.

For quality teaching, it is essential to maintain a permanent balance between (minimum) teacher guidance and (maximum) students' independence (Blum, 2015). For this reason, students were guided at a minimum level during the process, and they were mostly encouraged to act independently. Teacher support was more in the first weeks of the process. In the following weeks, teacher support decreased and student independence increased. After the end of the process, the opinions of the students about the activities were taken through Modeling Activities Opinion Form. Then quantitative data were collected by performing post-tests. The application process of the research is presented in Figure 2:

Figure 2

The Main Implementation Process of the Research



Findings

Findings on the Relationship between Reading Comprehension Skills and Mathematical Modeling Competence

The relationship between students' mathematical modeling competencies and reading comprehension skills pre-test scores and post-test scores is given in Table 2 together with the sub-steps of mathematical modeling competencies:

Table 2

Pre-test and Post-test Scores for the Relationship between Reading Comprehension Skills and Sub-Steps of Mathematical Modeling Competence

		Pre-test			Post-test		
		N	*r*	*p*	*N*	*r*	*p*
	Mathematical Modeling	26	.247	.223	26	.708	.000
Reading Comprehension	Understanding the Problem	26	.379	.057	26	.613	.001
	Simplification	26	.229	.261	26	.537	.005
	Mathematicalization	26	.182	.372	26	.592	.001
	Working mathematically	26	.159	.439	26	.644	.000
	Interpretation	26	.057	.782	26	.529	.005
	Verification	26	.188	.358	26	.563	.003

When Table 2 is examined, it is seen that there is a low level positive relationship between reading comprehension pre-test scores and pre-MMCT scores, r=.247, p>.01. However, there is no significant relationship between these two variables. Likewise, when analyzing the results of the analysis on the relationship between the students' pre-test scores in reading comprehension skills and each sub-level of mathematical modeling, it is seen that there is a low-level positive relationship between the students' reading comprehension skill and the scores of each sub-step of mathematical modeling competence. When the post-test scores are examined, it is seen that there is a high level, positive and statistically significant relationship between reading comprehension post-test scores and post-MMCT scores, r=.708, p<.01. Accordingly, it can be said that as the reading comprehension skill increases, the level of mathematical modeling competence also increases. Considering the determination coefficient (r^2=.50), it can be said that 50% of the total variability in mathematical modeling competence is due to reading comprehension. When looking at the relationships between the students' reading comprehension post-test scores and the scores of each sub-level of mathematical modeling competence, it is seen that these relations are moderately, positively and statistically significant. In this case, it can be said that as the students' reading comprehension skills increase, the success levels of each sub-step of mathematical modeling competence also increase.

In the interviews with the students at the end of the implementation process, the students emphasized that in order to solve a mathematical problem or complete a mathematical activity, the problem or activity in question should be understood correctly and completely. The opinions of S20, S8 and S23 students who are at the level 1, 2 and 3 in terms of reading comprehension skills are presented below as an example:

> S20: "…*The events seem to call us to read a book. Because the more books we read, the easier we can understand and make the questions*..."

S20 student, who is at the level 1 in terms of reading comprehension skill, stated that reading a book will make it easier to understand the questions, thus increasing the success in modeling activities. Similarly, S8 stated her opinion as;

> S8: "…*Yes, it has a relation with reading comprehension. If we didn't understand what we read, we wouldn't know what the problem is asking us. For example, it wants us to explain the problem in our own words in the question. If we cannot understand what we have read, we cannot answer that question*…".

According to the S8 student who is at the level 2 in terms of reading comprehension skill, solving a mathematical modeling problem depends on expressing what is desired in the problem. S23 student expressed his opinion as,

> S23: "…*These activities have something to do with reading comprehension. Because if we cannot understand what we are reading, we cannot know what the problem requires from us and we cannot solve the problem. In order to be successful in the activities, we must read books frequently so that we can understand the problem when we read the problem*…".

S23 student, who was at level 3 in terms of reading comprehension skill, stated that they could not know what is wanted in the problem without understanding what

they read and emphasized the need to read books in order to understand the problems better.

Development of Mathematical Modeling Competencies in the Process

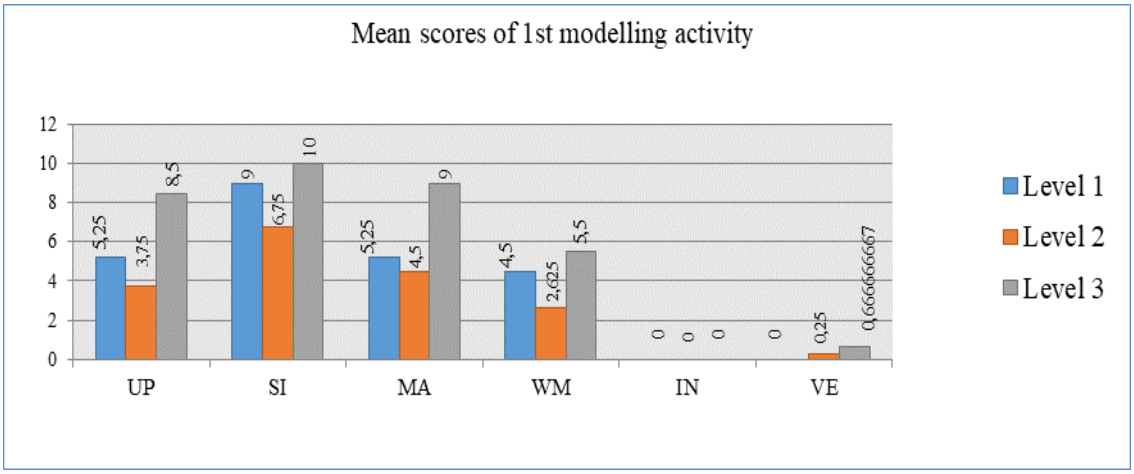
The findings obtained in the context of this sub-problem are divided into two parts so that they can be understood more easily by the reader. In the first part, each activity was considered a case. The mathematical modeling competencies of students with different levels of reading comprehension skills during the implementation process were examined in detail with qualitative and quantitative findings. In the second part, each mathematical modeling competence was considered a case, and it was attempted to summarize how the development of mathematical modeling competencies progressed through the seven activities according to the reading comprehension skill levels of the students.

Examining the Development of Modeling Competencies according to Different Reading Comprehension Levels on the Basis of Activity

Findings regarding the First Mathematical Modeling Activity. In the first activity of the study, "Football League", information was given about the points obtained from the matches played in the football league, according to the status of victory, draw and loss. and the students were asked to make possible predictions about the score of their favorite team at the end of the 4th week of the league. As a result, by the end of the 4th week of the league, they were asked to make possible predictions about the score of their favorite team. The scores of the students, who were divided into three levels according to the scores that they got from the reading comprehension test, from the first modeling activity "Football League" are given in the Figure below according to each sub-step of mathematical modeling:

Figure 3

Students' Modeling Efficacy Score Averages in the 1st Activity according to Their Reading Comprehension Levels

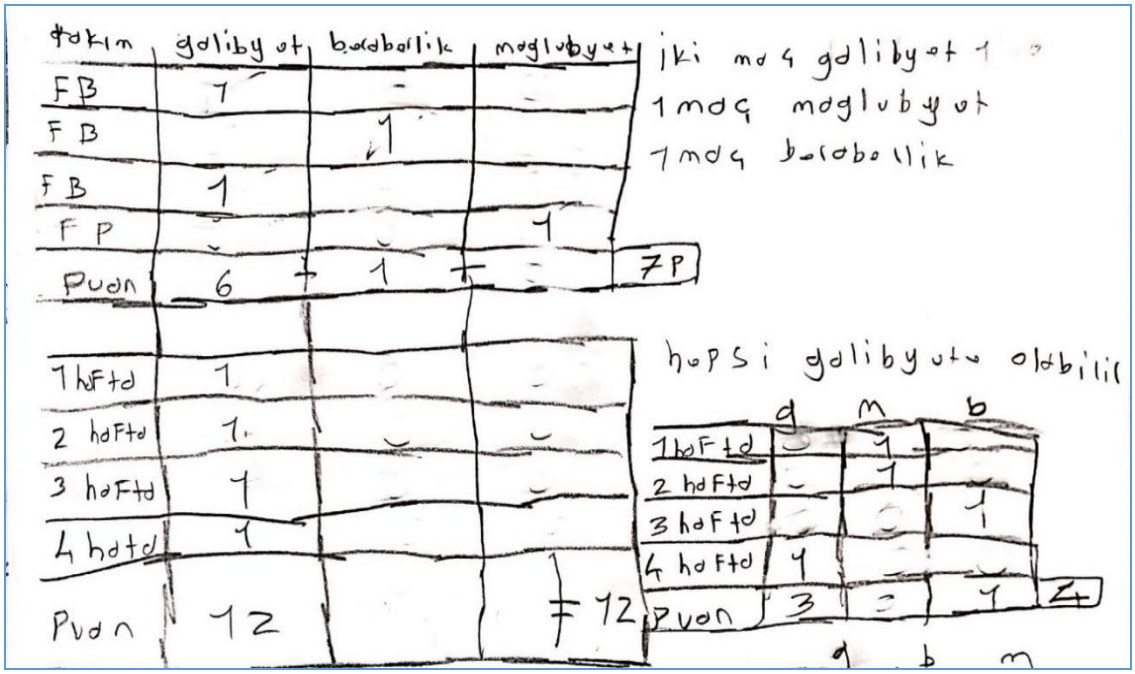


As seen in Figure 3, the students' average scores at the level 3 with the highest reading comprehension skills, according to each step of the mathematical modeling, were higher than the level 1 and level 2 students. The mean scores of mathematical

modeling efficacy of the students at the level 2 were higher than the level 1 students only in the verification step, and remained behind the level 1 students in the other levels. When the opinions about the activity were examined, it was seen that male students reported more positive opinions than female students. When looking at the Figure, it is seen that the step in which students at all three levels have the highest average is the "simplification" step. However, it is seen that students at all three levels fail in the "interpretation" and "verification" steps. In the opinions taken from the student diaries about this activity, it was seen that the students generally stated that they had difficulty with understanding the activity. Figure 4 shows the activity sheet of the S7 student at level 2 in terms of reading comprehension skill:

Figure 4

Activity Sheet of Student S7

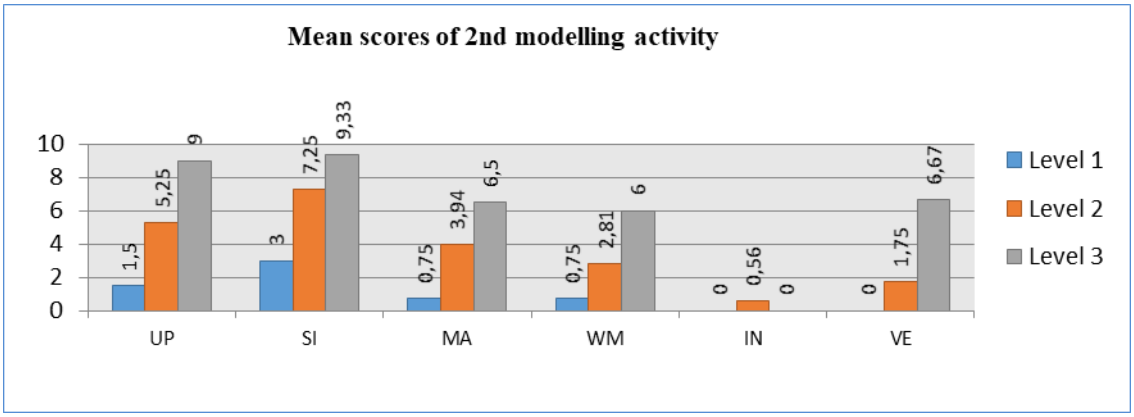


As seen in Figure 4, the student preferred to visualize his solution by drawing a table. The student, who succeeded in understanding the problem, simplifying and mathematical study steps, missed some of the possibilities that could occur and could not complete the solution completely. The student was also unable to comment on the solution and did not check the accuracy of the obtained solution. This situation shows that the student is partially successful in this modeling activity.

Findings regarding the Second Mathematical Modeling Activity. In the second activity of the study, "Bekir's Birthday Party", students were given three price options for a drink order at a birthday party and were asked at least how many drinks they should order in order for the second option to be more convenient than the others. The student scores of this activity, which is also applied individually, are given in the Figure below:

Figure 5

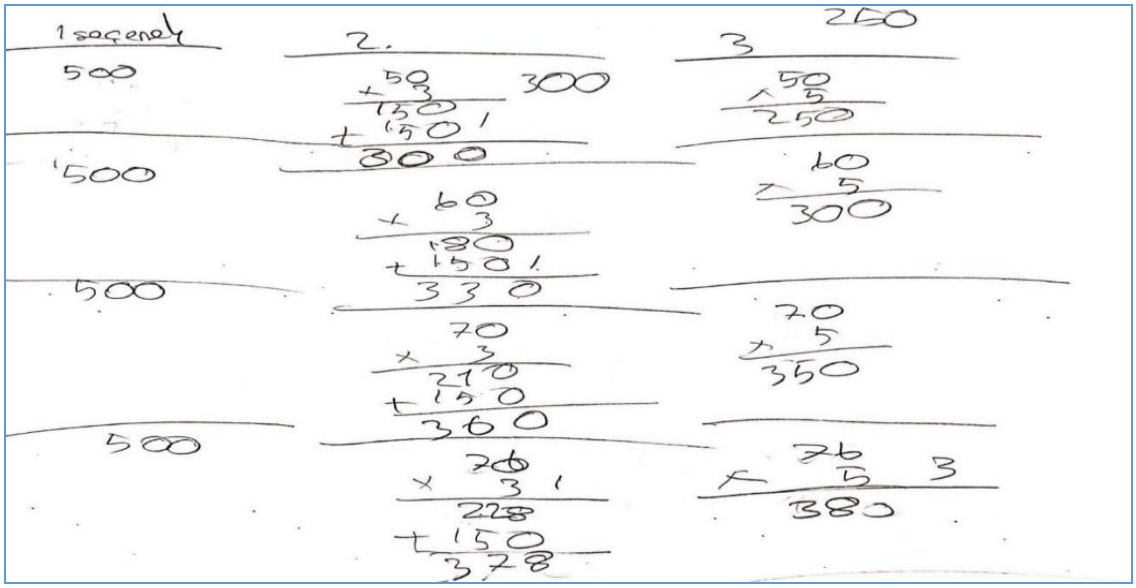
Students' Modeling Efficiency Score Average in the 2nd Activity according to Their Reading Comprehension Levels



When Figure 5 is examined, it is seen that the students at level 3 are more successful than the students at level 1 and 2, and the level 2 students than the level 1 students in terms of reading comprehension skill. Only in the "interpretation" level, the averages of the students at level 2 seem slightly higher than the others. The reason for this is that only one student at level 2 commented on the found solution. It is seen that the students are weak in the interpretation step in this activity, as in the previous activity. On the other hand, it is seen that there is a significant increase in the averages of level 3 students in the "verification" level. When the averages are examined in general, it is seen that the students at the level 1 and 2 have a higher mean score in the "simplification" level, and the level 3 students in the "understanding the problem" and "simplification" levels compared to the other levels. When the students' opinions about this activity were taken, it was seen that the students expressed more positive opinions in this activity compared to the first activity. Figure 6 shows the activity sheet belonging to student S6 who is at level 3 in terms of reading comprehension:

Figure 6

Activity sheet of student S6

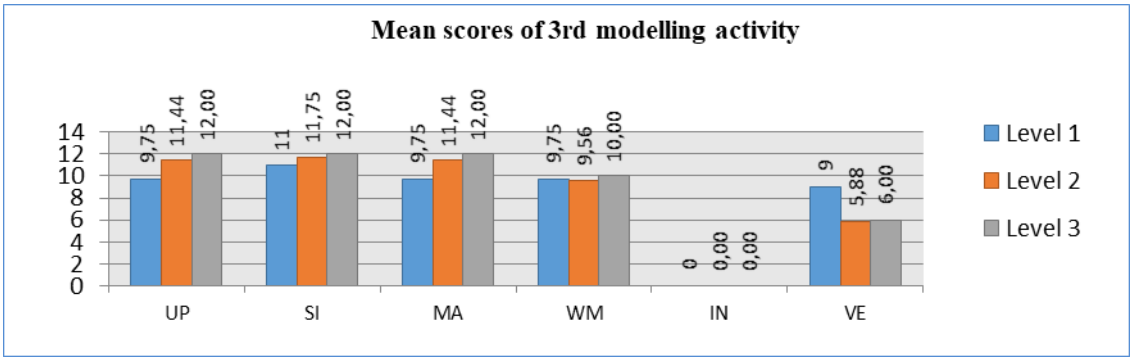


As can be seen in the Figure, the student tried the numbers of 10 by 10 in order to find the number of drinks that would make the 2nd option advantageous, and thus reached the correct answer. It can be said that the student, who developed a way to reach a solution, successfully completed the modeling process up to the mathematical study level. However, the student could not interpret his solution and verify the obtained solution. In this case, it can be said that the student partially completed the modeling process in this activity. In addition, in this activity, it is seen that level 3 students achieved a higher success in the activity compared to other students, and none of the students at the level 1 could not come to the solution stage by creating a suitable model for the solution of the problem.

Findings regarding the Third Mathematical Modeling Activity. In the third activity of the study, "The Mystery of Unit Cubes", students were asked to create completely different rectangular prism models of 48-unit cubes. In order to make the activity fun and to realize permanent learning, the students were divided into groups and 48-unit cubes were given to each group. The data regarding the student scores obtained as a result of evaluating the students' activity papers are shown in the Figure below:

Figure 7

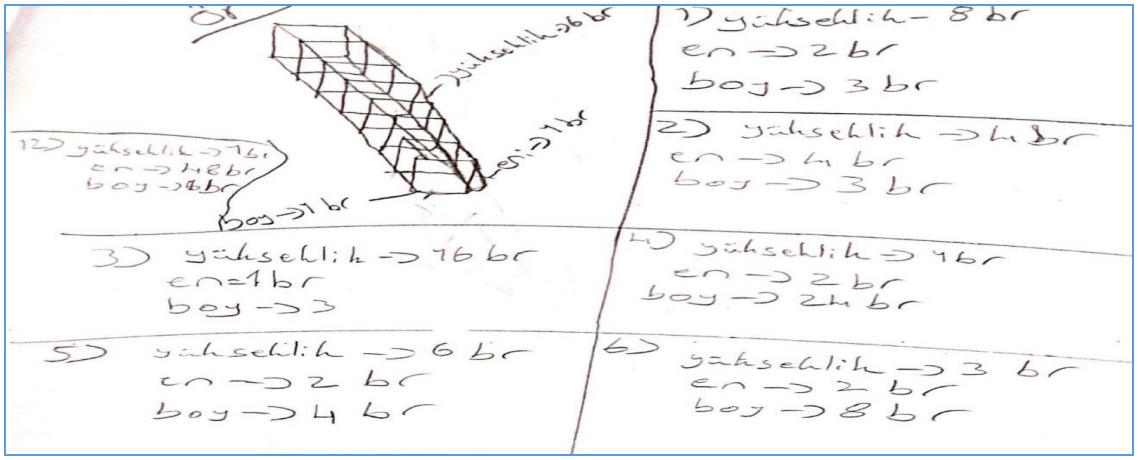
Students' Modeling Efficiency Score Average in the 3rd Activity according to Their Reading Comprehension Levels



As can be understood from Figure 7, the mean scores of the level 3 students are higher in the first four levels than the other students. In the "verification" step, it is seen that the averages of the level 1 students are higher. In addition, it is seen that the students failed in the "interpretation" stage in this activity. In addition, it is seen that the students are generally successful in other steps except for the "interpretation" step. When the students' opinions about the activity were received, almost all of them stated that they liked the activity. The reason was explained by using concrete materials and working in groups. Figure 8 shows the activity sheet belonging to the student S20 at level 1 in terms of reading comprehension:

Figure 8

Activity Sheet of S20 Student

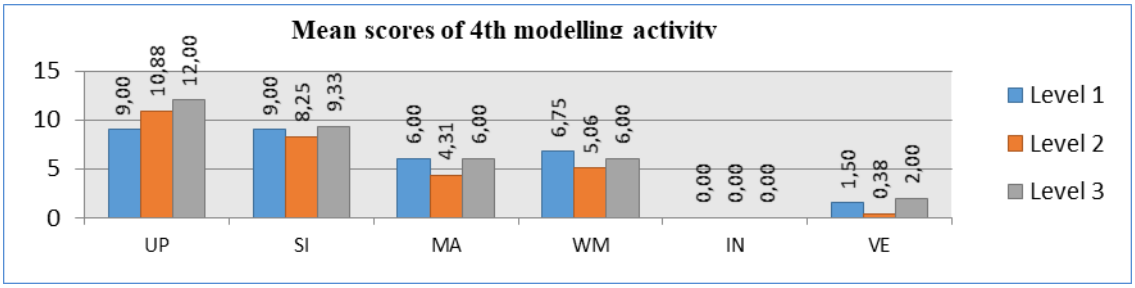


As seen in Figure 8, student S20 wrote the width, length and height of the rectangular prism models that can be created with 48 units of cubes. However, since rectangular prism models that can be written on the student's solution sheet are missing, it cannot be said that the student has reached a complete mathematical solution. In addition, in this activity, some students used visual figures while writing rectangular prism models, while the student S20 wrote the values that only width, length and height can take. The student, who could not interpret the solution, was able to verify his solution by reaching the relation that the product of width, length and height is equal to the volume of the rectangle.

Findings regarding the Fourth Mathematical Modeling Activity. In the "Cinema Hall" activity, which is the fourth activity of the research, the students were asked to find out how many square meters of space for a 300-person cinema hall in accordance with the standards. Information such as how many seats will be in horizontal and vertical rows, how wide the seat width or door gap should be, are left to the students' preference. Students were asked to obtain this information required for the solution of the problem by assuming. In this activity, which was also implemented in groups, the scores of the students according to different levels of reading comprehension skills are given in the Figure below:

Figure 9

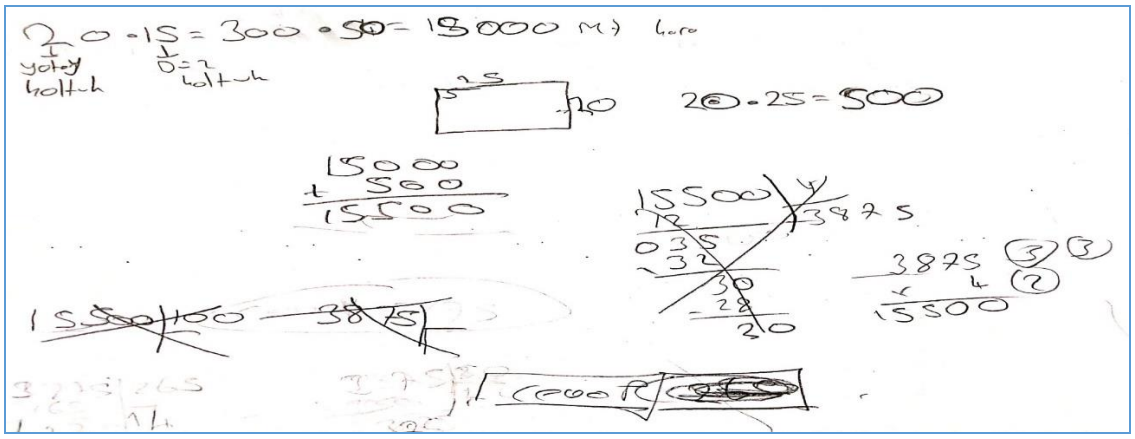
Students' Modeling Efficiency Score Average in the 4th Activity according to Their Reading Comprehension Levels



As seen in the Figure above, the students with the highest average in the steps of "understanding the problem", "simplification" and "verification" were again at the level 3. The students who could not succeed in the "interpretation" level were also weak in the "verification" level in this activity. The interesting situation that emerged in this activity is that the students who have little interest in the lesson and who are at the level 1 in terms of reading comprehension skills have high averages especially in this activity. Moreover, it is seen that these students are more successful in mathematical modeling skills, except for "understanding the problem" and "interpretation" skills, compared to students at level 2 in terms of reading comprehension skills. In this activity, in terms of reading comprehension skill, the modeling step in which level 2 and 3 students achieved the most success in general was the "understanding the problem" step, and the step where level 1 students achieved the most success was the "simplification" step. In Figure 10, a section is given from the activity sheet of student S16 at level 1:

Figure 10

Activity Sheet of S16 Student

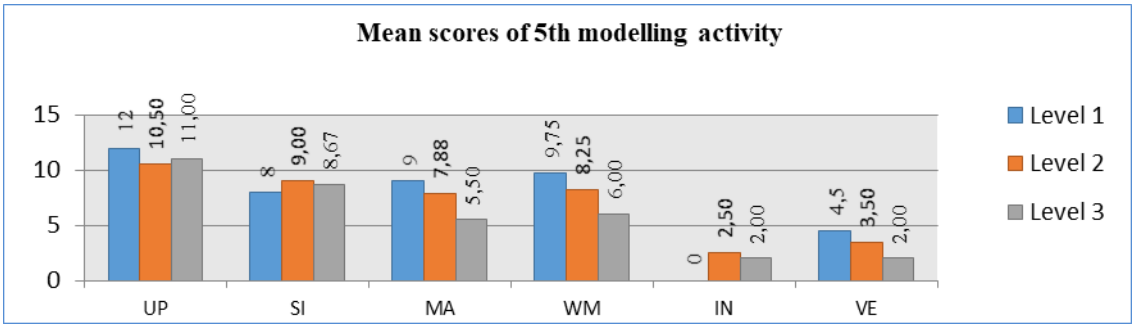


In this activity, the student S16 made a reasonable assumption about the number of seats that should be in a horizontal and vertical row, but it was seen that student did not follow a logical path in solving. In this case, it can be said that the student made missing assumptions and formed an incomplete model. Considering the student diaries, it was seen that the students generally stated that they had difficulty in the activity, and the reason for this was that they had trouble in forming assumptions.

Findings regarding the Fifth Mathematical Modeling Activity. In the "Electricity Saving" activity, which is the fifth activity of the process, students were asked to find the annual amount of electricity savings if each family in the country saves 1 hour from the lights of the rooms in their home. The population of the country and the amount of energy consumed by a light bulb per hour were given to students as additional information, and information such as the number of households in the country and the number of rooms in each household was left to the student's preference and they were asked to make assumptions about this. The Figure with the mean scores of mathematical modeling competence according to the reading comprehension skill levels of the students is given below:

Figure 11

Students' Modeling Efficiency Score Average in the 5th Activity according to Their Reading Comprehension Levels

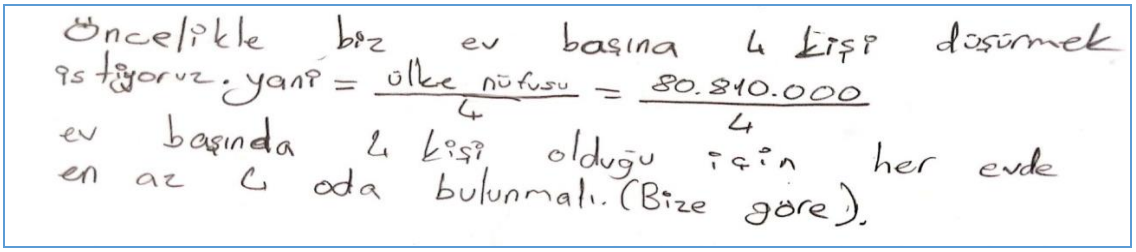


As seen in Figure 11, students at the level 1 in terms of reading comprehension skill, except for "simplification" and "interpretation" skills, showed higher success in other mathematical modeling skills compared to the students at the level 2 and 3 in this activity. In addition, from the student diaries at the levels 2 and 3 regarding this activity, it was seen that these students stated that they had difficulty in forming assumptions as in the previous activity and therefore they did not like the activity.

The fact that the mean score of all students in the "understanding the problem" level is higher than the mean score in other steps in this activity indicates that they understand the problem but have difficulty in reaching a solution. In Figure 12, the activity sheet of the student S25 who is at the level 2 in terms of reading comprehension is given:

Figure 12

Activity Sheet of Student S25


Öncelikle biz ev başına 4 kişi düşmek istiyoruz. yani = ülke nüfusu / 4 = 80.840.000 / 4
ev başında 4 kişi olduğu için her evde en az 4 oda bulunmalı. (Bize göre).

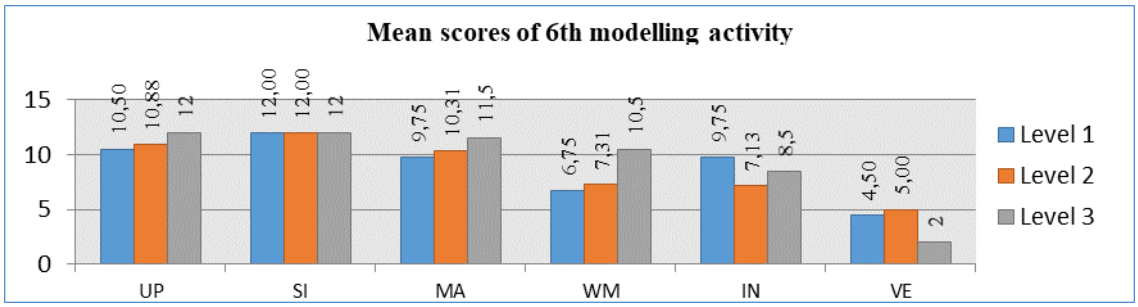
As can be seen in the Figure 12, the student made a reasonable assumption for the solution by determining the average number of people in the family as 4 and the total number of rooms in a family of 4 people as 4 (The house, bathroom, entrance, etc. locations are not taken into account).

Findings regarding the Sixth Mathematical Modeling Activity. In the "Oil Spill" activity, the sixth activity of the implementation process, students were asked to find the area where the oil spilled as a result of the puncture of an oil tanker spread to the sea. Although the students who could not compare the area where the oil spreads to the shapes, they are familiar with, such as square or rectangle, had difficulty at the beginning of the activity, they tried to find the area of the shape by trying to compare it to a square or rectangle. The mean scores obtained by students from each step of

mathematical modeling according to their reading comprehension skill levels are given in the Figure below:

Figure 13

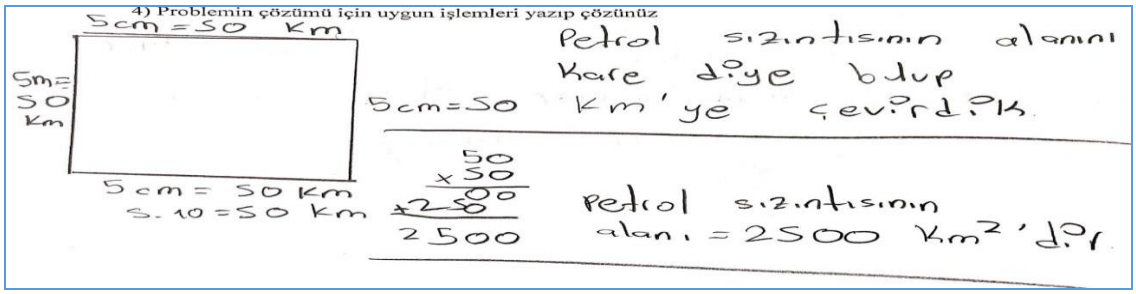
Students' Modeling Efficiency Score Average in the 6th Activity according to Their Reading Comprehension Levels



As seen in the Figure 13, the students with the highest average in the levels of "understanding the problem", "mathematization" and "mathematical study" were level 3 students, while the level 1 students at the "interpretation" step and the level 2 students at the "verification" step had a higher mean score than the other students. Moreover, in terms of "interpretation" and "verification" efficacies, level 1 students were more successful than level 3 students. The solution sheet of the activity of student S13 who is at the level 2 in terms of reading comprehension is given in Figure 14:

Figure 14

Activity Sheet of Student S13

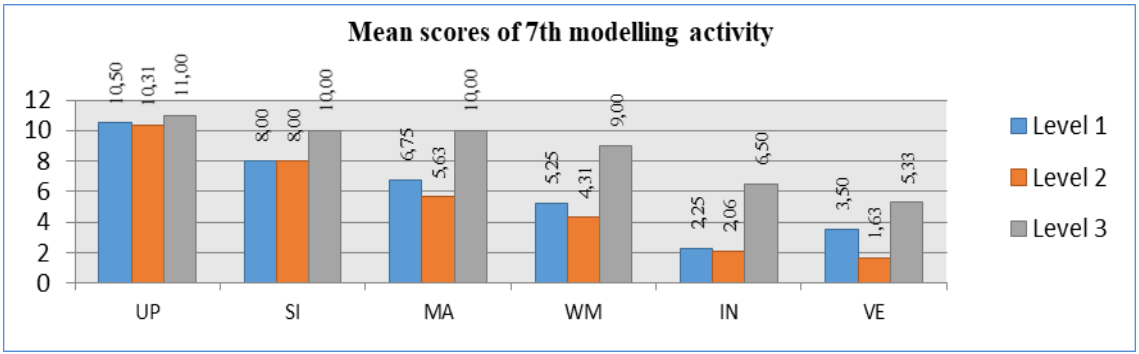


As seen in the Figure 14, the student thought of the shape as a square and calculated its area by measuring the length of one side with a ruler. The student's assumption that the shape is square and the measurements made with a ruler ensured that the student's estimated result was close to the truth.

Findings regarding the Seventh Mathematical Modeling Activity. In the seventh activity of the process, the students were asked to estimate the total amount of precipitation in 2019 by giving the annual rainfall figure between 1981-2016 in their province. In this individually implemented activity, the students did not experience any difficulties in understanding the problem step, but had difficulties in creating a mathematical model. The mean scores obtained by the students from each step of mathematical modeling according to their reading comprehension skill levels are given in the Figure below:

Figure 15

Students' Modeling Efficiency Score Average in the 7th Activity according to Their Reading Comprehension Levels

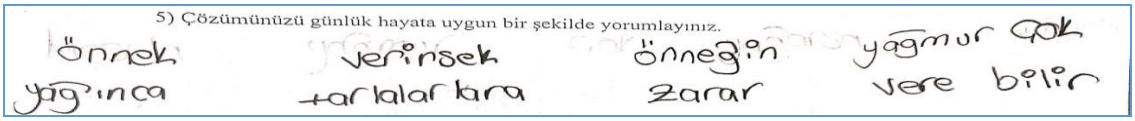


Looking at the Figure 15, it is seen that the modeling step in which all of the students are most successful in general is the "understanding the problem" step, and the level 3 students have the highest average in every step of mathematical modeling. In addition, this activity, which is applied individually to the students, reveals how the development of mathematical modeling competencies of the students progressed compared to the first activity.

Below, sample opinions taken from activity papers belonging to three level student groups are presented to interpret the problem:

Figure 16

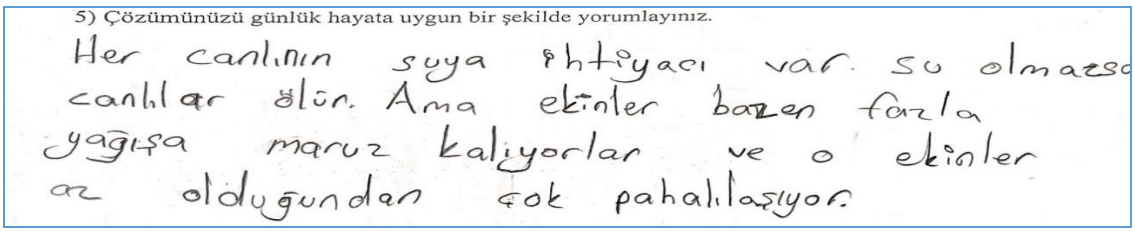
A Section from the Activity Sheet for "Interpreting the Problem" of the Student S17



Student S17, who is at the level 1 in terms of reading comprehension skill, answered the instruction question corresponding to the interpretation step of mathematical modeling as above. The comment made by the student as "For example, when it rains a lot, it can damage the fields" is realistic and logical as well as short and insufficient. In Figure 17, the comment of the student S25 at the level 2 of the same activity is seen:

Figure 17

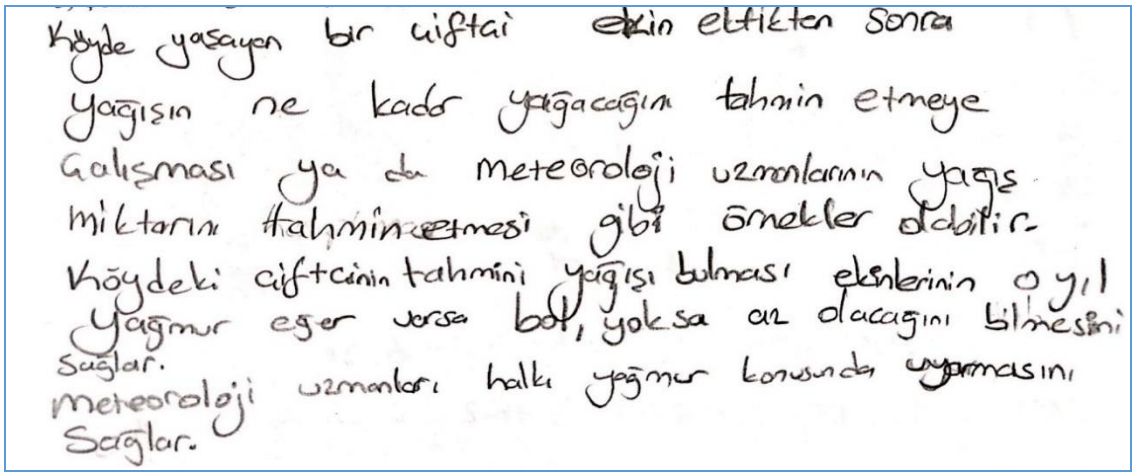
A Section from the Activity Sheet for "Interpreting" the Problem of Student S25



As can be seen in the Figure 17, the student said, "Every living thing needs water. Without water, living beings would die. But crops are sometimes exposed to high rainfall and they get very expensive because they are less", is more revealing than the previous student's comment. In addition, this student justified his interpretation different from the previous student. The opinion of the student S19, who is at the level 3 in terms of reading comprehension skill, taken from the activity sheet for "interpreting" the problem is presented below.

Figure 18

A section of the S19 student's activity sheet for "interpreting the problem"



In the Figure above, the interpretation of the solution that student S19 at the level 3 has made is given. The student stated through saying "There may be examples such as a farmer living in a village trying to predict how much rain will fall after planting a crop or meteorologists predicting the amount of rainfall. Finding the estimated rainfall allows the farmer in the village to predict that their crops will be abundant if there is rain that year, or less. It enables meteorologists to warn the public about rain" where the solution he obtained could be used in daily life and what kind of benefits it provided. The given examples support the view that students with advanced reading comprehension skills are generally more successful in mathematical modeling activities.

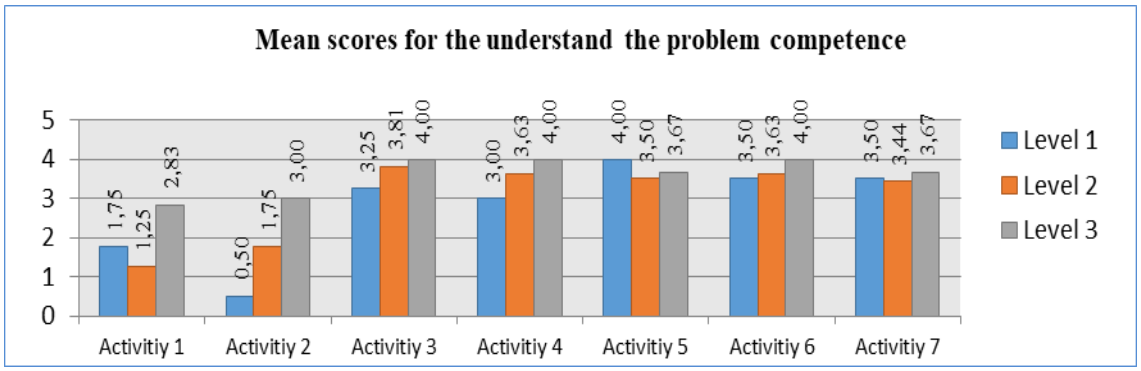
Change of Mathematical Modeling Sub-Competences According to Reading Comprehension Levels

The findings on how each mathematical modeling sub-competence of students at different levels in terms of reading comprehension skills changed during the application process are discussed below.

The Status of the Students in terms of Understanding the Problem Competence. The change in the students' competence to understand the problem during the application process is presented in the column chart below.

Figure 19

Change in Understanding the Problem Competencies according to Students' Reading Comprehension Level

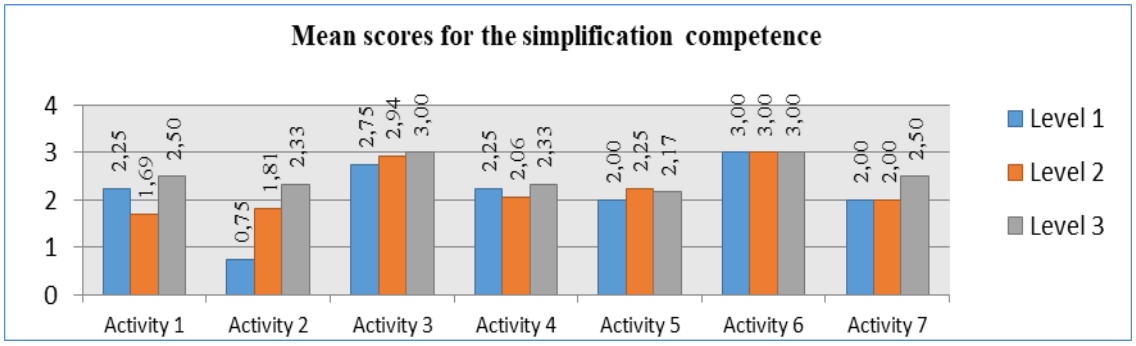


As seen in the Figure 19, the scores of the students' level of understanding the problem in the last five activities increased significantly compared to the first two activities. However, although the last activity was applied individually, the students' scores of understanding the problem were roughly similar to the previous activity scores. In addition, in all activities except the activity 5, level 3 students had a higher mean score in the level of understanding the problem than the other students

The Situation of the Students in terms of Simplification Competence. The change in the simplification competencies of the students during the application process is presented in the column chart below.

Figure 20

Change in Simplification Competencies according to Students' Reading Comprehension Level

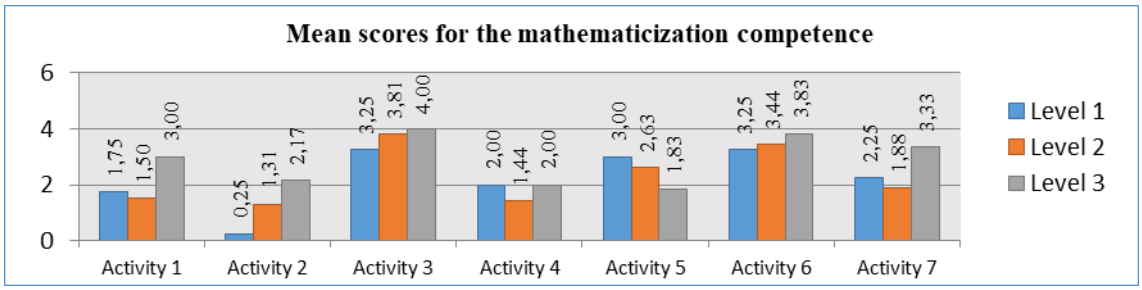


Together with the level of understanding the problem, this step was the modeling step in which the students achieved the most success compared to the other steps. On the other hand, it is observed that there is no regular development from the first activity to the last activity. It is seen that the students got higher scores in the activities 3 and 6 in the simplification step. In parallel with this, it was seen that the students gave more positive opinions about these activities in the process. When looking at the Figure 20, it can be seen that level 3 students generally have a higher mean score in the simplification step than other students.

The Status of Students in terms of Mathematicization Competence. The change in the simplification competencies of the students during the implementation process is presented in the Figure below.

Figure 21

Change in Mathematicization Competencies according to Students' Reading Comprehension Level

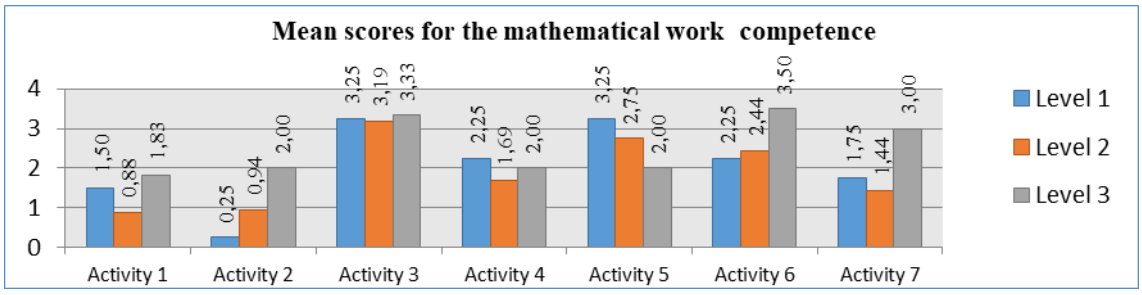


It is observed that the development of students in the mathematicalization step from the first activity to the last activity does not follow a regular course. In this modeling step, it is seen that the activities with the highest scores are the activities 3 and 6 as in the previous step. Looking at the Figure, it can be seen that the level 3 students generally have a higher mean score than the other students in the mathematization step.

The Status of Students in terms of Mathematical Work Competence. The change in the mathematical study competencies of the students during the implementation process is presented in the column chart below.

Figure 22

Change in Mathematical Work Competencies according to Students' Reading Comprehension Level

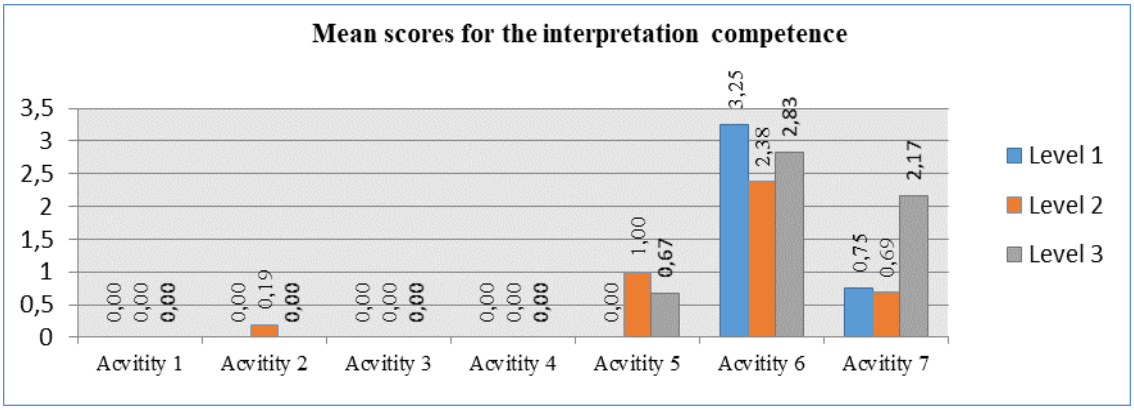


When the Figure 22 is analyzed, it is seen that the achievement scores of all three levels of student groups have increased compared to the first two activities. In all activities except activities 4 and 5, it can be seen that level 3 students have higher mean score success than other students.

Status of Students in terms of Interpretation Competence. The change in the interpretation competencies of the students during the implementation process is presented in the column chart below.

Figure 23

Change in Interpretation Competencies according to Students' Reading Comprehension Level



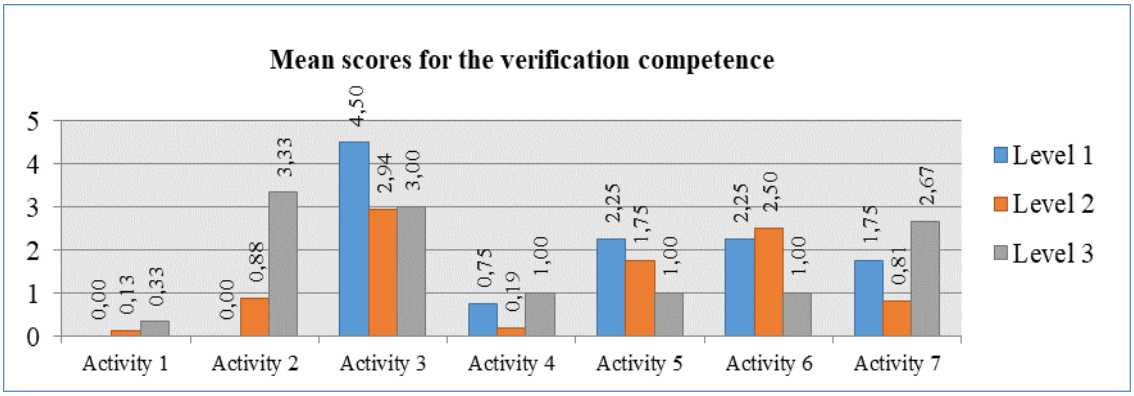
As can be seen in the Figure, there has been an increase in the interpretation step mean score of the students in the last three activities. As a matter of fact, it has been observed that most of the students devote the entire time remaining after reaching the solution stage in a given modeling problem to completing and checking the solution.

Some students stated that they forgot to interpret after completing the solution in the process. As a matter of fact, the students did not experience time problems in the activities carried out by the group in the process, and they needed more time in individual activities. In the last individually applied activity, some students stated that they allocated the entire time to the solution and to check the solution and that they could not find time to interpret.

Status of Students in terms of Verification Competence. The change in the verification competencies of the students during the application process is presented in the column chart below.

Figure 24

Change in Verification Competencies according to Students' Reading Comprehension Level



When the Figure is examined, it is seen that the activity with the highest mean score in the verification step is the activity 3, in other words the "Unit Cubes" activity. On the other hand, when looking at the last four activities, it can be seen that the total

verification scores of the students increased in general. As a matter of fact, it is seen that the students at the level 3 in the verification step in the activities 1, 2 and 7 implemented individually have higher scores.

Discussion and Conclusion

In this study, the effect of MAIP on mathematical modeling competencies of students with different levels of reading comprehension skills was examined. The first sub-problem of the study examined the relationship between students' reading comprehension skills and their mathematical modeling competencies. As a result of the analysis, it was observed that there was a positive, low level relation between the scores of reading comprehension skills and mathematical modeling competence before the process, and a positive, high-level relationship between the scores of reading comprehension skills and mathematical modeling competence after the process. In addition, reading comprehension skill scores were associated with each step of mathematical modeling and it was seen that this relationship was significant for each step. This finding shows that the mathematical modeling competencies of students with advanced reading comprehension skills are also more advanced than other students. The reason why this relationship is higher in post-test scores compared to pre-test scores can be explained by the fact that students who encounter mathematical modeling problems for the first time may follow similar ways in solving the problems; therefore, the levels of modeling competence of students at different levels in terms of reading comprehension skills have not yet differed from each other. Ural and Ülper (2013) evaluated the reading comprehension skill and mathematical modeling competence of prospective teachers through the "understanding the problem" step in their studies. They stated that the prospective teachers who were successful in the "understanding the problem" step, one of the mathematical modeling steps, understood what they read well. In addition, Biccard (2010) suggested that the failure of students with poor mathematical skills to complete some mathematical modeling tasks is related to their reading level and reading comprehension. However, it was stated that this link was beyond the scope of Biccard's work and should be considered as a complete study on its own. Plath and Leiss (2018) also investigated the effect of linguistic complexity on solving mathematical modeling tasks in their studies with middle school students. They stated that reading comprehension greatly influenced the creation of an appropriate case model and the successful solving of a mathematical modeling task. Krawitz et al. (2017), on the other hand, concluded that, contrary to expectations, reading comprehension does not have much effect on mathematical modeling performance and stated that the reason for this may be related to the fact that the modeling problems they present to students are challenging even for students with a good understanding. The results obtained from the studies in general support the view that there is a relationship between mathematical modeling and reading comprehension skills.

In the second sub-problem of the study, the development of mathematical modeling competencies of the students was evaluated according to their reading comprehension level. The mathematical modeling competencies of the students, who were divided into three levels according to their reading comprehension test scores, were analyzed from the first activity to the last activity and comparisons were made. The first two activities were applied individually and as expected, the students at the 3rd

level were more successful. However, students at the 1st level in the first activity showed more success than the 2nd level students. This can be because students at the 2nd level are mostly girls and are less familiar with football than boys (All of the students in the 1st level are boys.). The third activity was held in groups at the intensive request of the students, and students generally progressed in all sub-levels except the interpretation step. In this activity, 3rd level students achieved more success in the first four steps of mathematical modeling. The fourth, fifth and sixth activities were also carried out in groups, as the students achieved success in this group activity. In the fourth activity, 3rd level students were generally more successful, but in this activity they were weak in the verification step compared to the previous activity. The fact that this activity requires more complex operations compared to the previous activity can be shown as a reason for this situation. In addition, in this activity, it was observed that students also had difficulties in making assumptions. When it comes to the fifth activity, it is seen that there is an increase in students' success in the interpretation step. In this activity, it is striking that 1st level students are more successful in the UP, MA, WM and VE levels than other students. It can be said that working in groups has a significant effect on the success of 1st level students. The fact that 3rd level students are less successful may be due to the fact that this activity includes crowded operations. As a matter of fact, it was understood from the students' opinions taken at the end of the activity that the students did not like the activities with crowded operations. 3rd level students were generally more successful in the sixth activity. In addition, it is seen that there is a significant increase in the interpretation step in this activity. The last activity was applied individually in order to observe the progress of the students more clearly. In this activity, it was observed that 3rd level students were much more successful than other students, while 1st and 2nd level students' achievement levels were almost close to each other. In this activity, it is also seen that there is a significant improvement in the interpretation step of the students.

Another point that should be emphasized in the study is that students are more successful in the activities they like. When students' favorite activities are considered, it is seen that there are activities that do not involve complex operations, such as "The Mystery of Unit Cubes" and "Oil Spill". They disliked activities such as "Cinema Hall" and "Electricity Saving" that required much mathematical processing. This finding provides important data on how the activities should be in order to develop a positive attitude towards students' mathematical modeling activities.

If the development of mathematical modeling sub-competencies of students is examined in the process, it will be seen that 3rd level students are more successful than other students in general. This finding shows that reading comprehension skill affects not only the level of understanding the problem, but also the success in other sub-levels of mathematical modeling. Özsoy et al. (2015), also found in their study that students' problem-solving skills vary according to different reading levels. On the other hand, another remarkable finding in the study is that the steps in which students show the highest success are "understanding the problem" and "simplification" steps, and the steps they have the lowest success level are "interpretation" and "verification" steps. Tekin-Dede and Yılmaz (2015) also observed in their study with 6th grade students that students experienced the most difficulties in the interpretation and verification stages. Yurtsever (2018) also reached a similar result by observing a decrease in the modeling

competence of students from understanding the problem to the verification step in her study. Similar findings can be found when the international literature is examined (Blum, 2011; Ji, 2012; Maaß, 2006). One of the reasons for the low level of success in the interpretation step is that students finish the solution after finding the answer to the problem in classical math questions, therefore they are not used to interpret the answer. In addition, many students stated that they forgot to interpret the solution after the activity was ended. During the process, some students stated that they did not know how to associate with daily life, comment, or express the interpretation after they obtained the solution. It was observed that students also had difficulties making assumptions, again due to the absence of classical mathematical problems. This situation may be due to the inability of students to develop their expression and prediction skills due to the lack of reading habits, and also to the difficulties they experience in associating the solution of the problem with daily life due to the limited socio-cultural environment in rural areas.

Implementations

In the light of the findings obtained from this study, the following implementations are made:

Increasing the use of mathematical modeling activities in lessons and providing teachers in-service training on mathematical modeling may be beneficial in terms of effective teaching and permanent learning. In addition, due to the absence of a control group and the limited number of students in this study, it is thought that more experimental studies, especially with a control group, are needed to examine the relationship between mathematical modeling competencies and reading comprehension skills. In this respect, it is recommended to conduct research at different grade levels related to the subject.

Considering that students like activities with less complex operations more, students who are new to mathematical modeling can be recommended to apply activities that will improve their skills, such as understanding the problem, reasoning, making assumptions, and making comments, instead of activities involving complex operations. In fact, activities can be designed specifically to develop each mathematical modeling sub-competency. For example; As seen in this study, considering that students failed especially in interpretation and verification stages while solving mathematical modeling problems, it is recommended that teachers apply mathematical modeling activities based on interpretation in their lessons. In order to overcome the deficiencies in interpretation skills of the students, cooperation can be made, especially with Turkish course teachers. In addition, considering that students are more successful in activities in which they work in groups, it is recommended to implement the activities in groups.

Considering the relationship between mathematical modeling competencies and students' reading comprehension skills, it can be said that the failure of some students in mathematical modeling processes is due to their difficulties in reading comprehension. In this regard, it is recommended to take more effective steps to improve students' reading comprehension skills. It should not be forgotten that reading comprehension is the basis for understanding and solving a problem, and it should be ensured that teaching practices that increase the level of reading comprehension are given to students from primary school years.

It is recommended to prepare activities that can be given as homework to students who are at a low level in terms of reading comprehension skills to benefit from modeling activities. Care should be taken that these activities are aimed at understanding the problem and do not contain crowded operations that will distract the student from the activity and the lesson. In addition, since the problems in the existing textbooks do not appeal to modeling too much, it is recommended to change the textbooks to create textbooks that include mathematical modeling activities suitable for different levels and to create teacher guide books that contain instructions on how to apply the activities.

Statement of Responsibility

Yasemin Alkan; research design, analysis, methodology, data collection, resources, discussion, conclusion, writing-original draft, writing - review & editing. Mehmet Aydın; methodology, writing -original draft, writing - review & editing, resources, discussion, conclusion, supervision.

Conflicts of Interest

There are no conflicts of interest in this study.

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Pre-Service Teachers' Understandings of Doing Statistics in the Context of Teaching Graphs*

Öğretmen Adaylarının Grafiklerin Öğretimi Bağlamında İstatistik Yapmaya İlişkin Anlayışları

Nadide YILMAZ** **İ. Elif YETKİN-ÖZDEMİR*****

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ABSTRACT: It was aimed to examine pre-service teachers' developing understandings of doing statistics within a lesson study. It was focused on their understandings (i.e., content knowledge) of doing statistics as well as how they transform their understandings (i.e., content knowledge) into teaching practices (i.e., knowledge of student & knowledge of teaching) while designing and implementing lessons related to graphs. Three senior pre-service teachers participated in a two phase (university and school classroom) lesson study. Data were collected through lesson plans prepared by the pre-service teachers in groups, observations, field notes, semi-structured interviews and video and audio recordings of the group meetings and instructional implementations. Results showed that they did not consider doing statistics as it consisted of many inter-related components initially. Their understandings developed greatly as they designed lesson plans, discussed the concepts and reflected on their lesson plans and instructional implementations. Their starting to put statistical questions into the center of doing statistics became an important turning point that affected their conceptions related to other themes (e.g., collecting data, interpreting graphs). It was also observed that their understandings related to doing statistics impacted their teaching practices.

Keywords: Doing statistics, teaching graphs, lesson study, pre-service teachers, middle school grades.

ÖZ: Bu çalışmada öğretmen adaylarının istatistik yapma konusundaki anlayışlarının ders imecesi/araştırması bağlamında incelenmesi amaçlanmıştır. Öğretmen adaylarının istatistik yapma sürecindeki anlayışlarının (alan bilgisi) grafiklerle ilişkili ders planlarken ve uygularken nasıl değiştiği ve nasıl öğretim pratiklerine dönüştüğüne (öğrenci ve öğretim bilgisi) odaklanılmıştır. Çalışmaya üç son sınıf öğretmen adayı katılmış, iki aşamadan oluşan (üniversite ve gerçek okul) ders imecesi/araştırması uygulaması gerçekleştirmişlerdir. Öğretmen adayları tarafından grup halinde hazırlanan ders planları, gözlemler, alan notları, yarı yapılandırılmış görüşmeler ve grup toplantılarının video ve ses kayıtları ve öğretim uygulamaları aracılığıyla veriler toplanmıştır. Öğretmen adayları başlangıçta istatistik yapma sürecinin birbiriyle ilişkili birçok bileşenden oluştuğunu düşünmemişlerdir. Ders planları tasarladıkça, kavramlar hakkında tartıştıkça anlayışları gelişmiş; bu gelişim ders planları ve öğretimsel uygulamalarına büyük ölçüde yansımıştır. İstatistiksel soruları istatistik yapmanın merkezine koymaya başlamaları, diğer temalarla ilgili fikirlerini (örneğin, veri toplama, grafikleri yorumlama) etkileyen önemli bir dönüm noktası haline gelmiştir. Ayrıca istatistik yapmakla ilgili anlayışlarının öğretim uygulamalarını doğrudan etkilediği de gözlemlenmiştir.

Anahtar kelimeler: İstatistik yapma, grafiklerin öğretimi, ders imecesi/araştırması, öğretmen adayları, ortaokul seviyesi.

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** *Corresponding Author*: Asst. Prof. Dr., Karamanoğlu Mehmetbey University, Karaman, Turkey, nadideylmz70@gmail.com, https://orcid.org/0000-0003-1624-5902
*** Assoc. Prof. Dr., Hacettepe University, Ankara, Turkey, elif.yetkin.ozdemir@gmail.com, https://orcid.org/0000-0001-8784-0317

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The increasing need for statistics has led to increased awareness of the importance of this field (Eicher & Zapata-Cardana, 2016). This awareness has also been reflected in education and "how the teaching and learning of statistics should be" has become one of the important research topics (Batanero et al., 2011; Shaughnessy, 2007). Even though there are similarities between statistics and mathematics, some fundamental differences gave rise to the need to address the learning and teaching of these fields separately (Garfield & Ben-Zvi, 2004; Groth, 2007). Although mathematics is used in statistics, non-mathematical issues (e.g., deriving meaning from data by using context) also play an important role in doing statistics (delMas, 2004; Groth, 2007; Rossman et al., 2006). This gave rise to the recognition that the statistics needed for teaching contain different information than teaching mathematics. Researchers have pointed out that this knowledge should be defined (Groth, 2007; Moore, 1988).

Four components of doing statistics are emphasized for learning and teaching statistics: (1) formulating questions, (2) data collection, (3) analyzing data and (4) interpreting results (Bargagliotti et al., 2020; Carver et al., 2016; Franklin et al., 2005; Ministry of National Education [MoNE], 2018; National Council of Mathematics [NCTM], 2000). Formulating questions refers to identifying the problem situation and defining the question(s) that can be answered by data (Franklin et al., 2005). At the heart of a statistical research, there are questions that can be answered by collecting and analyzing data (Arnold, 2008). The questions should allow data collection (English et al., 2017; NCTM, 2000), contain a specific purpose (Graham, 2006) and related to a context. Also, the features of the group from which data will be collected should be clearly explained when formulating questions (English et al., 2017). Data collection is another component of doing statistics. This involves making and implementing plans to gather appropriate data (Schwartz, 2008). Selecting the most suitable and efficient data collection methods and collecting data appropriately are important skills in statistics. On the basis of the questions, decisions should be made about the variables (e.g., achievement, preference, etc.), data collection tools (e.g., observation, interview, questionnaire) and the population and sampling methods (Bargagliotti et al., 2020; Franklin et al., 2005). In addition, issues such as reaching the target population and ensuring the independence of observations are important points to be taken into consideration (Bargagliotti et al., 2020). Analysis of the data, another component of doing statistics, involves selecting and applying suitable data analysis methods (Bargagliotti et al., 2020; Franklin et al., 2005). Organizing data in terms of tables and graphs, calculating measures of central tendency and measures of dispersion are necessary in order to answer the research questions (MacGillivray & Pereira-Mendoza, 2011). The last component of doing statistics is interpreting results. At this component, meanings are derived from the findings and they are associated with the research questions asked at the beginning (Franklin et al., 2005). The interpretation process is made up of two levels (Curcio, 1987; Friel et al., 2001). The first level is reading between the data, where the reader tries to make sense of the data by performing quantitative comparisons (larger, less) and mathematical operations (addition, subtraction, multiplication, division). The next level involves reading beyond the data. At this level, the information in the graph and the reader's previous knowledge are integrated, and from here, expansions, inferences, and predictions are made (Curcio, 1987; Friel et al., 2001).

All components of doing statistics has been emphasized and specific expectations related to doing statistics as a research process were stated on the current middle school mathematics curriculum (MoNE, 2009, 2013, 2018). However, researchers argue that the components of doing statistics are usually covered separately in instructional practices, which could constraint students to develop statistical understandings (English, 2014; Güven et al., 2015; Hacısalihoğlu-Karadeniz, 2016; Öz, 2019; Pfannkuch, 2005). Numerous studies have reported that both teachers and pre-service teachers consider concepts and ideas related to statistics as separated (Batanero et al., 2010; Burgess, 2001, 2002; Chick & Pierce, 2008; Gürel, 2016; Heaton & Mickelson, 2002; Ijeh, 2012; Kurt, 2015; Leavy, 2006; Mercimek, 2013; Reston et al., 2006; Santos & Ponte, 2014; Sorto, 2004), which might influence their teaching of statistics. For instance, Sorto (2004) revealed that pre-service teachers had difficulty associating the questions they formulated with graphical representations. Likewise, Batanero et al. (2010) observed that only one-third of the pre-service teachers who participated in their study were able to associate their comments with the formulated question while interpreting the graphs. Several studies have also revealed that both pre-service and in-service teachers focused on procedural aspects such as drawing graphs or making calculations correctly rather than emphasizing and relating the components of doing statistics (Chick & Pierce, 2008; Heaton & Mickelson, 2002; Ijeh, 2012; Mercimek, 2013; Reston et al., 2006).

Students need more opportunities to formulate questions, collect data and interpret results based on the formulated questions to develop statistical thinking skills (Ader, 2018; Makar & Fielding-Wells, 2011). This requires that pre- and in-service teachers have the knowledge and skills related to the components of doing statistics (Heaton & Mickelson, 2002; Makar & Fielding-Wells, 2011). Teachers' having the necessary knowledge and skills to develop these understandings undoubtedly plays an important role in the success of the targeted statistics education (Carver et al., 2016; Franklin et al., 2015; Van de Walle et al., 2010). For teacher educators, how pre-service teachers will acquire this knowledge and skills is an important problem because the teaching-learning process has a more complex structure than it is thought (Grossman et al., 2009; Hiebert et al., 2007; Morris et al., 2009). At this point, it is very important to develop learning environments that allow pre-service teachers to practice as well as to acquire theoretical knowledge (Zhang & Cheng, 2011). Although experiences in university classrooms offer valuable insights, they are usually limited in developing knowledge and skills provided by real classroom environments (Cohan & Honigsfeld, 2006; Grossman et al., 2009). The lesson study model allows pre-service teachers to work collaboratively in planning, implementing and evaluating lessons toward a common goal. In this way, the model facilitates teacher knowledge and skills (Borko, 2004; Fernandez, 2005; Meyer & Wilkerson, 2011; Murata, 2010; Wright, 2009; Yamnitzky, 2010; Zhang & Cheng, 2011).

This study aimed to examine pre-service teachers' developing understanding of doing statistics within a lesson study that lasted for three months. We focused on their understandings (i.e., content knowledge) of doing statistics as well as how they transform their understandings (i.e., content knowledge) into teaching practices (i.e., knowledge of content and student & knowledge of content and teaching) while designing and implementing lessons related to graphs. The study's findings could

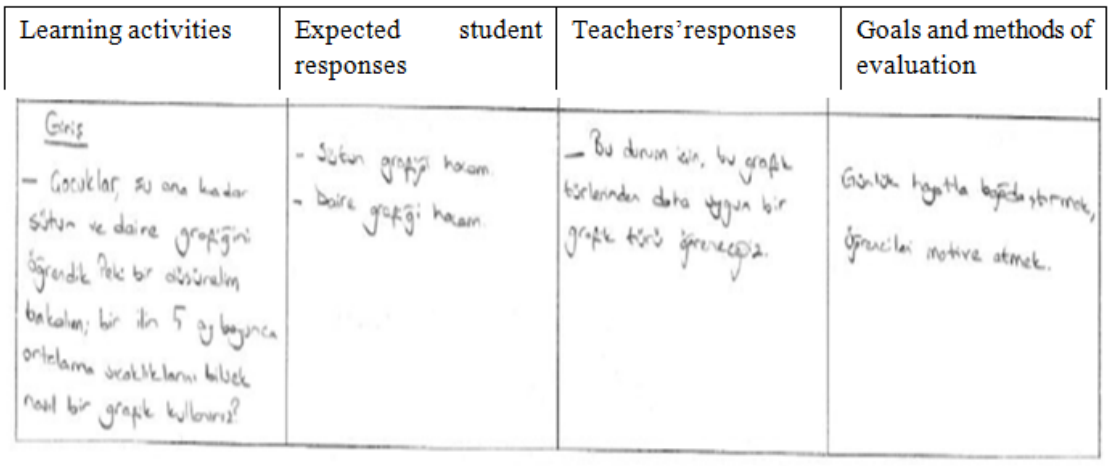
inform researchers about teacher learning of doing statistics and how their understandings could evolve with practice in the university and real-classroom environments. In this way, findings could also reveal ideas for teacher educators in structuring pre-service teacher education programs.

Method

Holistic single-case study was utilized. The case examined in this study is the group of three pre-service teachers who conducted three lesson study cycle in their last year of the undergraduate program training middle school mathematics teachers. Criterion sampling was used when selecting the participants. Among 12 pre-service teachers who completed the required content and pedagogical content courses (e.g., statistics and probability, methods of teaching mathematics) and volunteered to participate in the study, Gamze, Şirin and Beyza[1] were selected for in-depth analysis. The interviews and small group work at the beginning of the study showed that this group took more active roles and expressed themselves better than other volunteers. They also demonstrated typical difficulties and conceptions reported in the literature (e.g. focusing on the procedural aspects, ignoring the process of doing statistics). The fact that the great majority of the students attending teacher education programs are females resulted in all the participants of the current study being females. The group focused on seventh grade learning objectives related to graphs: (1) Constructs a pie graph of a data set and interprets it (2) Constructs a line graph of the data and interprets it and (3) Shows the data related to the research questions with a suitable representation (pie graph, a frequency table, a bar graph or a line graph) and makes conversions between the representations. The pre-service teachers were expected to design, conduct and revise three lesson plans during the spring semester of the 2016-2017 academic year. They were asked to prepare lesson plans according to a format with four components: learning activities, expected student responses, teacher's responses, goals and methods of evaluation (Figure 1).

Figure 1

Sample Lesson Plan

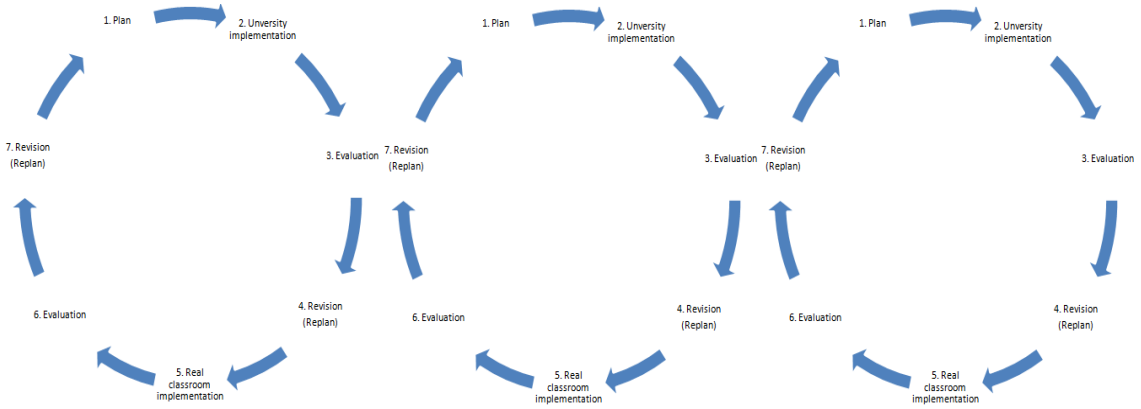


[1] All names are pseudonymous

Then each group member implemented one lesson plan primarily in the university classroom and then in the real middle school classroom. The lesson plans were conducted by Gamze, Şirin and Beyza, respectively. After each implementation, the lesson was evaluated and revised by the group members. For the university implementation, both researchers (the first and the second author) and other pre-service teachers in the program participated in and evaluated the implementation of the lesson. For the real middle school classroom implementation, the first author and the mentor teacher were present and evaluated the implementation with the group members. This procedure can be seen in Figure 2.

Figure 2

Lesson Study Model (Adapted from Zhang & Cheng, 2011)



Instructional activities in the university and real classroom environment as well as the meetings for planning, evaluating and revising the lesson plans, were video-recorded and transcribed into documents. Lesson plans prepared by the pre-service teachers, video-recorded and transcribed lesson study meetings (for planning, implementation and evaluation) and classroom instructions (university implementation and real classroom implementation), semi-structured interviews, observation forms filled out by the observers, field notes taken by the first author and reflective papers written by the pre-service teachers were used as data collection tools. Data collected by these tools are used to describe pre-service teachers' decisions and actions reflecting their initial and evolving understandings at each phase of three lesson study cycle.

The descriptive analysis method was employed. Each cycle of lesson study depicted in Figure 2 (plan, university implementation, evaluation, revision/replan, real classroom implementation, evaluation, revision/replan) was analyzed separately. We analyzed the group's all instructional decisions (implemented or ignored) and actions related to teaching statistics. For instance, we examined the tasks and activities they designed to introduce the topic, the questions they asked the students to explore the topic as well as their explanations and responses to students' questions. We first coded these instructional decisions and actions to describe how the pre-service teachers address each component of doing statistics (i.e., formulating statistical questions, collecting, analyzing and interpreting data) when designing and implementing lessons. Interpreting these codes within and across each component of doing statistics (i.e.

formulating statistical questions, collecting, analyzing and interpreting data) revealed some themes as important understandings for teaching statistics. For instance, understanding the role of context emerged as a new theme related to each component of doing statistics. Likewise, understandings related to variable type emerged as another theme. We observed that pre-service teachers struggled with designing and implementing lesson plans when they did not take into account the role of context and variable type and decided to include these themes as necessary understandings for teaching statistics.

Furthermore, understanding the roles of graphs emerged as another theme since the pre-service teachers were aimed to teach graphs in the lesson study. Therefore, seven themes emerged: understandings related to the (1) statistical questions, (2) data collection, (3) the role of graphs, (4) the role of context, (5) variable type, (6) graph construction and the elements of the graph and (7) reading and interpreting graphs. Under each theme, we also explored whether and to what extend pre-service teachers transform their understanding into teaching practices. Finally, analyses from each cycle of lesson study were compared to seek any changes and development in pre-service teachers' understandings of doing statistics and teaching practices.

Various measures were taken to ensure the validity and reliability of the data. Purposive selection of the participants and the use of different data collection tools are thought to have strengthened the transferability of the study and contributed to credibility and dependability. In addition, presentation of the data collection and data analysis processes to the reader through detailed explanations can be argued to have contributed to not only the transferability and dependability of the study but also to its confirmability. The code list was created by the authors together. The first author coded the raw data (documents and observations) at different periods (at an interval of three months). The rate of agreement between these two coding was found to be 90%. In addition, an expert coded twenty-five percent of the data, and the inter-coder reliability was found to be 85%. On the points where there was disagreement in the coding, the authors and the expert were discussed together and reached a consensus. Thus, it can be argued that the current study satisfies the criterion of validity (Miles & Huberman, 1994). On the basis of these results, it can be said that the current study is credible and dependable.

Ethical Procedures

Ethical approval was sought from Provincial Directorate for National Education, the participating school and university for video-recordings of the teachers to be used in the study. Also, the name of prospective teachers remained anonymous. The ethical committee approval date is May 2, 2016 and the number of their approval document is 35853172/433-1358.

Results

Findings of the study are presented under seven themes emerged: understandings related to the (1) statistical questions, (2) data collection, (3) the role of graphs, (4) the role of context, (5) variable type, (6) graph construction and the elements of the graph and (7) reading and interpreting graphs. Under each section, we described the groups' understandings and how they transformed their understanding into instructional

practices. In order to depict the development observed over the phases of three lesson study cycles, findings are summarized in tables with sample criteria related to each theme.

Understandings Related to the Statistical Questions

The development of pre-service teachers' understandings and their instructional practices related to statistical questions are summarized in Table 1.

Table 1

Understandings Related to the Statistical Questions

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Thinking and discussing about statistical questions	-	-	-	√	-	√
Supporting students to formulate their own statistical questions	-	-	-	√	√	√
Including a problem statement or a purpose in the tasks	-	-	-	√	-	√
Supporting students to establish the relationship between the questions formulated in the task and the type of graph	-	-	-	√	√	√

UC: University classroom environment

RC: Real middle school classroom environment

In the lesson study related to the first objective (constructing and interpreting pie graph)[1], it was observed that the pre-service teachers did not take into consideration the fact that doing statistics starts with statistical questions. They presented a bar graph and asked students to construct the same data with a pie graph without any reason or purpose. Their statements such as "*let's convert the bar graph into a pie graph"* (*University Planning-Lesson study 1)* indicate their lack of attention for the purpose of drawing graphs. Even after the expert (the second author) emphasized the need for a purpose by stating, *"Why do we construct a pie graph? We need to think about it."* the pre-service teachers did not make any revisions on their plans. Likewise, they didn't consider statistical questions as they planned for the second objective (constructing and interpreting line graphs)[2]. Şirin made an introduction to the lesson by saying, *"Let's suppose I present you 5-day average temperatures of a city. I want to express this data in a graph. What kind of graph should I use?" (University Implementation-Lesson study 2)*. The expert, again, brought up the fact that there should be a purpose: *"For what purpose do we use statistics? Why do we compare here [temperatures]?" (University Evaluation-Lesson study 2)*. After the evaluation meeting, pre-service teachers revised the task as follows:

[1]Constructs a pie graph of a data set and interpret it (7th grade).
[2]Constructs a line graph of the data and interpret it (7thgrade).

Figure 2

Revised Task-Lesson Study 2

"Uncle Hasan will plant a vegetable in his garden. In order to get the highest yield from this vegetable, the temperature change should be the least for 2 days after the day it is planted. Below is the weather forecast for the next 14 days. Let's find the best days for Uncle Hasan to plant."

1	2	3	4	5	6	7	8	9	10	11	12	13	14
20°C	23°C	25°C	22°C	19°C	23°C	26°C	24°C	25°C	26°C	25°C	23°C	20°C	24°C

Here, the question pre-service teachers formulated is structured around a problem statement and includes an objective. During the implementation in the real classroom environment, Şirin asked questions to test whether a bar graph would be suitable for answering the question as shown below:

> Real Classroom Implementation-Lesson study 2
>
> Şirin: Now, which graphs have we learned?
>
> Student: Bar graph, pie graph, tally, frequency table.
>
> Şirin: Yes, we have learned these graphs. So, what kind of graph was the bar graph? Let's construct a bar graph. Let's see whether it is a suitable graph for these data or for the thing I am exploring [i.e., which days are the best days to plant]?

By asking questions, Şirin encouraged students to consider the problem as well as the relationship between the problem and the type of graph to be used. Even though the pre-service teachers began to understand the role of statistical questions, developing a deeper understanding seems to take more time and experience. The task they designed for the third objective (selecting and converting representations)[1] did not include a problem situation and purpose at first: *"The table presents favourite school subjects in the class 7/A. Construct the appropriate graph according to the table. Select three school subjects, interpret their status and find the percentages."* After the implementation in the university classroom, the lack of a statistical question (a problem or a purpose) in the task came up as an issue again. The group revised the task to include a problem statement and a purpose: *"The table presents favourite school subjects in the class 7/A. The teacher wants to know whether mathematics is a popular subject in the school. Construct the appropriate graph according to the table. Interpret the status of mathematics and two school subjects you selected."* The revised task was formulated around a question: *"Is math a favourable school subject among students?"* This revision shows that even though pre-service teachers still struggle with thinking and discussing about statistical questions, they began to design instructional tasks including a problem statement or a purpose for collecting or analyzing data with some help.

Understandings Related to the Data Collection

The development of pre-service teachers' understandings and their instructional practices related to data collection are summarized in Table 2.

[1]Shows the data related to the research questions with a suitable representation (pie graph, a frequency table, a bar graph or a line graph) and makes conversions between the representations (7th grade).

Table 2

Understandings Related to the Data Collection

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Relating data collection with statistical questions		-	-	-	-	-
Taking into account decisions about data collection (e.g., data collection tools, selecting participants)	-	-	-	-	-	-
Allowing students to think about collected data	-	-	√	√	√	√
Simulate simple data collection with students	√	-	-	-	-	-

UC: University classroom environment,

RC: Real middle school classroom environment

With regard to the first lesson plan related to constructing and interpreting pie graphs, the group included an activity to collect data. In the university classroom implementation, Gamze asked students about their favorite football team and made a list on the board. Even though she attempted to show students the process of data collection, she neither made explicit connections with the formulated question or purpose nor the selection of the participants. After this issue was discussed in the evaluation meeting, pre-service teachers revised their lesson plan for the real classroom implementation. Rather than collecting data in the classroom, Gamze showed students the data set and asked them how it could have been collected. However, she did not let students think about the data collection process and immediately responded to her own question: *"Now, do you know how we obtained these data? [without waiting for student response] You know we are enrolled in a university. I asked my classmates. The data belong to them…"* Here, students did not have opportunities to explore and discuss important elements of the data collection process (e.g., data collection tools, selecting the participants). After the evaluations on the first study lesson, pre-service teachers began taking more attention to let students think about data collection. During the real classroom implementation, Şirin asked the students how the data might have been collected and waited for the students' responses.

Real Class Implementation-Lesson study 2

Şirin: Now you can see the 14-day temperature change [pointing to the data on the board.] How do you think we have obtained the data? Let's first talk about it.

Student: You may have obtained from the weather forecast.

Even though these instances show some progress in their understanding of data collection, they failed to explore detailed analysis of data collection and to relate the data collection process with the question formulated in all three lesson study cycles.

Understandings Related to the Role of Graphs

The development of pre-service teachers' understandings and their instructional practices related to the role of graphs are summarized in Table 3.

Table 3

Understandings Related to the Role of Graphs

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Taking into account the role of graphs as organizing and representing data	√	√	√	√	√	√
Taking into account the role of graphs in answering statistical questions	-	√	-	√	√	√
Designing tasks to explore how different types of graphs display data differently	-	-	-	√	√	√
Supporting students to compare different types of graphs in relation to the formulated statistical questions	-	√	-	-	√	√

UC: University classroom environment

RC: Real middle school classroom environment

The pre-service teachers were observed to be focusing on the roles attributed to the graphs as tools for organizing and representing data. They ignored graphs' role as tools for answering statistical questions. For instance, when one student asked why they need to learn about line graphs in addition to pie graphs, Gamze explained that each type of graph provides a different way of representing data. She, however, did not focus on why it is important to represent data in different ways. This case shows that pre-service teachers have not understood that different types of graphs allow us to represent data in different ways, which helps us answer different statistical questions. This issue was discussed after the implementation. The pre-service teachers revised their lesson plan to explain that line graphs make it possible to compare changes in data sets. The revised plan also emphasized the idea that pie graphs allow us to see the ratio of parts to the whole data set. These explanations show that the pre-service teachers started to realize that pie and line graphs are tools for representation and tools for answering statistical questions. In the real classroom implementation, Gamze provided the opportunity for students to think about the function of the pie graph. When one student based her reasoning for using pie graphs on angles, Gamze emphasized that pie graphs make it easy to see the relationship between the part and the whole.

For the second objective, the pre-service teachers wanted to focus on the fact that line graph allows seeing the change in a data set. They decided to show students a line graph representing temperatures of a city and ask questions about the changes of temperatures. Şirin's statements such as "*Why do you think we connect them [points of change]?"* and *"You can see the decrease [in temperature] more easily in this way,*

can't you? For example, from Monday to Tuesday, it [the temperature] decreased" illustrates her effort to make the role of line graph as a tool to show change more explicit for the students.

Despite these instances, it was observed that the pre-service teachers still struggled with their understandings of graphs as tools to answer statistical questions into their teaching practices. For instance, one student suggested using a bar graph to represent the data (i.e., temperatures of a city). Her reasoning was that they could also see the change with bars. Here, Şirin merely confirmed her suggestion rather than using this opportunity to associate the role of graphs with the statistical question asked at the beginning. Here, the student's suggestion could have been used to explore the elements of line and bar graphs in relation to answering particular statistical questions: "lines are connecting the points to examine changes," whereas "height of bars help us to compare frequencies of categories." After implementing the lesson, the group discussed the statistical questions that can be answered by line graph. In the revised plan, they decided to ask the students to compare the problems that could be answered with a bar graph with the problems that could be answered with a line graph.

In the lesson planning meetings and implementations about the third objective, it was observed that the pre-service teachers focused more on the fact that graphs are tools to respond to statistical questions. During the university implementation, when Beyza noticed that students focused on the keywords while determining the suitable type of graph, she guided the students to think about the problem statement. The related section of the lesson is presented below.

> University Implementation-Lesson study 3
>
> Student: For example, when there is a temperature change or population change, I can use the line [graph].
>
> Beyza: Hımm. Only for temperature or population? What is important here, the temperature or the change [of the temperature]?
>
> Student: The change.
>
> Beyza: Yes, when you want to show something is changing [you'll use line graph].

Here, Beyza asked questions to understand if students focused on keywords when selecting the type of graph. Then she emphasized the necessity of making connections with a problem statement or a purpose. In the real classroom implementation, Beyza noticed that a group of students had difficulty understanding the roles of bar and line graphs. She asked questions such as "*When I construct a bar graph, what can I see? What can we see in the line graph?"* to help students focus on the distinctive characteristics each type of graph has. These findings show the development of groups' understandings about the role assumed by graphs in answering the formulated question.

Understandings Related to the Role of Context in Doing Statistics

The development of pre-service teachers' understandings and their instructional practices related to the role of context in doing statistics are summarized in Table 4.

Table 4

Understandings Related to the Role of Context in Doing Statistics

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Designing tasks involving meaningful contexts leading to statistical investigation	-	-	-	√	√	√
Considering students' overgeneralizations related to common contexts in statistical investigations	-	-	-	√	√	√
Designing tasks to reveal and overcome students' overgeneralizations related to common contexts in statistical investigations	-	-	-	√	√	√

UC: University classroom environment

RC: Real middle school classroom environment

While the pre-service teachers were planning their lessons in relation to the first objective, they considered the context highly restricted. For example, they included the following questions in their lesson plan *"Who supports which football team? If we organized and showed your responses on a graph, which graph would you use?" (University Plan-Lesson study 1)*. Even though the task constitutes a context related to daily life, it does not include a meaningful purpose: why do we need to know who supports which football team? Who wants to know this data? This approach caused them to experience difficulty when one student asked whether they could use a pie graph for representing a data set involving temperatures of a city. The following excerpt shows Gamze's response to the student:

> University Implementation-Lesson study 1
>
> Student: How about using a pie graph for displaying temperature?
>
> Gamze: You mean using a pie graph for displaying temperature? Tell me, what degrees of temperature [asking for the data]?
>
> Student: Let's say -2 and 5 degrees [in Celsius].
>
> Gamze: Hımm, are these for two different days? Do you think that representing these values [in pie graph] would be meaningful? Here [referring to the pie graph], we can see the number of people [referring to frequencies], can't we? For instance, the largest sector shows the highest number of people [frequency]. Here, how would I show 25 degrees [of temperature] [on pie graph]?
>
> ….
>
> Student: That means we cannot use the pie graph for every case, can we?
>
> Gamze: Yes. Each graph is suitable for certain cases.

Here Gamze's conception of context is limited to a case or a situation (e.g., temperature of a city, favourite sport teams) and data. Hence, she could not produce a new problem statement related to the given context that may require displaying data with pie graph.

While thinking about a context for the second objective, pre-service teachers paid great attention to the variable type and their being realistic. Yet, they still ignored the problem statement and purpose. Like the first study lesson, they presented a data set with a real-life situation without any problem statement or purpose (i.e., constructing a line graph for degrees of temperature of a city). After the evaluation of the delivered lesson, they revised the context around a certain goal (i.e., finding the best days for Uncle Hasan to plant his vegetables). During the implementation, Şirin asked students in which situations the use of a line graph would be suitable and evaluated students' responses by emphasizing the use of line graphs as displaying the change.

While determining contexts related to the third objective, the pre-service teachers tried to avoid typical contexts and attended to students' common misconceptions. They stated that *"Everybody thinks that votes should be represented on a pie graph. We selected this context on purpose; we wanted them to learn that when necessary, votes can be shown with a bar graph." (University Evaluation-Lesson study 3).* The task is presented as follows.

Figure 3

University Implementation-Bar Graph-Lesson Study 3

"…middle school vote counts for school president

Candidates	*Vote count*
Pelin	*78*
Veli	*57*
Alparslan	*99*
Aysel	*127*

In the table, the number of votes for the school president candidates in the … middle school is given. According to these data, draw a graph where you can compare the data and determine the president and vice president by looking at the graph."

Though the task includes a problem statement, the expression "compare the data" hints for students to construct a bar graph. Yet, the pre-service teachers' addressing an overgeneralization (i.e., the number of votes are represented with a pie graph) can be seen as a development from an instructional point of view.

During the university implementation, Beyza wanted students to present sample contexts for using different types of graphs. She talked about the importance of purpose when deciding the most suitable type of representation and stressed that the type of the variable is not the only criterion to be taken into account. During the implementation, the pre-service teachers observed that students tend to match certain contexts with certain types of graphs. In order to prevent these generalizations, they allowed students to discuss the context and the problem situation related to the context. While a line graph can be used when the change in the population is questioned, a bar graph is more suitable to represent the distribution of population across the years.

Understandings Related to the Variable Type

The development of pre-service teachers' understandings and their instructional practices related to the variable type are summarized in Table 5.

Table 5

Understandings Related to the Variable Type

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Considering the type of the variable as an important criterion in data analysis (i.e., in selecting the appropriate graphic representation)	√	√	√	√	√	√
Evaluating variable type within the context of the formulated question	-	-	-	√	√	√
Considering students' overgeneralizations regarding the relationship between the type of variable and the type of graph	-	-	-	√	√	√
Designing tasks to reveal and overcome students' overgeneralizations regarding the relationship between the type of variable and the type of graph	-	-	-	√	√	√

UC: University classroom environment

RC: Real middle school classroom environment

The pre-service teachers designed the tasks and activities based on the idea that *"quantitative (numerical) variables are represented with a line graph and categorical variables are represented with a pie or a bar graph."* When designing the lesson for the first objective, they mainly took into account the type of the variable. They know about variables (categorical or quantitative (numerical)) and used this criterion to decide which type of graph to use. Since they did not formulate a question initially, they disregarded the purpose of displaying data with graphs. Even though taking into account the type of variable is not false while deciding the most suitable type of graph, the pre-service teachers overlooked that some variables can be measured as categorical or quantitative (numerical) depending on the question. For example, a quantitative variable can be converted into a categorical variable depending on the question formulated by the researcher. Thus, while deciding the suitable type of graph, the type of the variable should be evaluated within the context of the question. This lack of knowledge on the part of the pre-service teachers resulted in their inability to answer the questions asked by students during the implementation. For example, one of the students asked "*Can we convert all the bar graphs into pie* graph*s?" (University Implementation-Lesson study 1)*. Gamze stated that because the variable given [degrees of temperatures] is continuous, using pie graph would not be suitable. Here she overlooked the fact that depending on the question and purpose, we could measure or convert data [degrees of temperatures] into a suitable form and use a pie graph. During

the reflection meeting, it was revealed that the pre-service teachers are of the opinion that a data set involving degrees of temperature should always be represented with a line graph because it is a continuous variable. Even though this issue was discussed, the group did not make any changes in their lesson plans and real classroom implementations.

With regard to the second objective, the pre-service teachers decided to introduce line graphs by making connections with bar graphs that students already knew. However, their conception about the relationship between variable type and graph type led them to focus on continuity of the variable and did not take the question or purpose into consideration. After the students had drawn the line graph, Şirin drew attention to the continuity of the variable. She stated that the bar graph is suitable for categorical variables and the line graph is suitable for quantitative (numerical) variables. However, her examples (representing the number of supporters for football teams with a bar graph; degrees of temperature in a day with a line graph) could have resulted in overgeneralization. She did not mention that the variables could be represented with different types of graph depending on the question or the purpose. This lack of understanding was observed in their responses to students' questions as well. For instance, when one of the students asked whether line graph is suitable to represent the precipitation rate, Şirin responded "*Yes, as it is* a *quantitative variable, it can be used."* In her response, she merely focused on the type of variable. After this instance was reminded and discussed in the evaluation meeting, they began to realize that while deciding on the type of graph, taking the variable type into account is not enough on its own. Şirin wrote in her reflection journal that *"I realized that I had been wrong about where to use the line graph. In this implementation, we learned that the line graph can be used with variables that are not continuous, that we need to decide depending on the question and that basically in situations where change can be observed, the line graph can be used*."

Related to the third objective in the real classroom implementation, Beyza asked students, "*Can I show the weight [of a group of people] with a bar graph?"* With this question, she intended to make students realize that weight can be represented with a bar graph when necessary. The pre-service teachers stated that students would overgeneralize weight as a continuous variable, and thus they felt the need to ask such a question. This instance also shows that the pre-service teachers considered the difficulties experienced by students and structured their implementations accordingly.

Understandings Related to the Graph Construction and Elements of the Graph

The development of pre-service teachers' understandings and their instructional practices related to the graph construction and elements of the graph are summarized in Table 6.

Table 6

Understandings Related to the Graph Construction and Elements of the Graph

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Understanding and relating basic elements of different types of graphs	-	-	-	√	√	√
Attending to student difficulties in drawing graphs	-	-	-	√	√	√
Guiding students to draw graphs	-	-	-	√	√	√
Supporting students to think about and relate basic elements of different types of graphs	-	-	-	√	√	√

UC: University classroom environment

RC: Real middle school classroom environment

In general, the pre-service teachers were observed to know the basic elements constituting a graph (e.g., bar heights, axes, scaling, lines, pie sectors). This caused them to think that the students also knew these elements. Therefore, they either did not focus on or implicitly mentioned these elements. Over time they realized that they needed to talk about these elements more explicitly. For instance, during the implementation of real classrooms, Beyza observed that one group of students construct the graph without paying attention to equal scaling. The dialogue below shows her guidance to the group:

> Real Classroom Implementation-Lesson study 3
>
> Beyza: Could we directly put the values like this [values not at equal intervals]? You put the values at equal intervals [referring to leaving equal space among different values].
>
> Student: No, we can't.
>
> Beyza: Then, how should we do? Look. Here, they wrote 57, then 63. Then they would write 68 with leaving the same interval between values. Can we do it like this? Then you will write here 127.
>
> …..
>
> Student: So, can we write it like 57, 67,87?
>
> Beyza: Yes, it can be. Why not. For example, you place the data at equal intervals *like 10, 20, 30... and then put the remaining data somewhere in-between them.*

Here, it is seen that Beyza asked questions that would lead students to think about how scaling should be done. We, however, did not observe an explanation or discussion about why equal scaling is important.

Implementations showed that pre-service teachers also struggled with understanding the basic elements of graphs in a given context. For instance, during the university implementation, Şirin asked which type of graph could be used to represent degrees of average temperature of a city for five days. Students stated that as the degrees of temperature may take negative values, a pie graph would not be suitable for representing these data. The dialogue below shows the class discussion.

> University Implementation-Lesson study 2
>
> Şirin: I will present average degrees of temperature of a city for five days. I want you to show this with a graph. Which graph do you think I should use?
>
> ….
>
> Student: I think we cannot use a pie graph because it might take negative or positive values. But can we show this [referring to negative values] in a pie graph?
>
> Şirin: Yes, a very good explanation. If there is a negative degree of temperature, using a pie graph seems to be a bit difficult.

In this example, Şirin seems to have experienced difficulty in understanding what a sector of a pie meant for this data set (i.e., degrees of temperature). She overlooked the fact that each pie sector represents the number of observations of each category (e.g., number of days with -5^{o}C), that is, the frequency. She tried to represent values (e.g., -5^{o}C) rather than frequencies with sector of a pie chart that leads her to reach an unreasonable conclusion. After the evaluation meeting in which this issue was brought up, the pre-service teachers emphasized what the whole of a pie graph and each sector represents in the real classroom implementation.

Understandings Related to Reading and Interpreting Graphs

The development of pre-service teachers' understandings and instructional practices related to the reading and interpreting graphs is summarized in Table 7.

Table 7

Understandings Related to Reading and Interpreting Graphs

	1st Lesson Study		2nd Lesson Study		3rd Lesson Study	
Criteria	UC	RC	UC	RC	UC	RC
Relating findings from graphical representations with formulated questions	-	-	-	-	√	√
Asking questions for the purpose of reading between data (i.e., compare and explore data within the graph)	√	√	√	√	√	√
Asking questions for the purpose of reading beyond data (e.g., making generalizations and predictions)	-	-	-	-	-	-

UC: University classroom environment

RC: Real middle school classroom environment

Pre-service teachers did not put much emphasis on reading tables and graphs. Even though Gamze pointed out that students may only focus on the points and ignore the values between them when reading the line graph, the group did not consider her idea when designing the lesson. Their understandings related to the interpretations of graphs mainly included reading between the data without taking into account the purpose of the questions. There were no instances observed related to reading beyond the data. For the first objective related to pie graphs, they planned to ask students questions to compare the categories/groups. Even though comparing categories presented in a pie graph is not incorrect, such interpretations could be made through bar graph as well. What makes pie graph distinct as a tool to represent data is that it allows us to see the relative contribution of each category within the whole data set. Below is presented the related section from the lesson environment.

> University Implementation-Lesson study 1
>
> Gamze: By looking at this graph, what can you tell about which person has the largest number of siblings, about numbers such as fewer or more? Look at them and try to interpret them.
>
> Student: For example, half of 20 is 10.There are 9 person having one sibling. The sum of two siblings and three siblings is also 9 persons. I added and found 18.
>
> ….
>
> Gamze: Correct, can you make comments such as this is more and that is less?
>
> Student: The number of those having one sibling is more than those of the others.

After the discussion at the reflection meeting, pre-service teachers decided to include explorations of the contributions of each category within the whole data set. In real classroom implementation, Gamze emphasized that some points that could not be clearly seen in the bar graph could be seen better in the pie graph or vice versa. In the third lesson study, the pre-service teachers focused more on interpretations of the graphs and made comments associated with the statistical question. For instance, when one student made a comment that would be more suitable for a bar graph instead of the pie graph, the pre-service teacher reminded the purpose of using pie graphs and make the student realize that the pie graph allows interpretation about the meaning of the related part within the whole.

Discussion and Conclusion

One of the important findings of the current study is that the pre-service teachers did not see the process of doing statistics as consisted of many inter-related components. In particular, they did not consider that doing statistics starts with formulating questions and that the question affects the subsequent processes such as collecting data, selecting types of data display and interpreting graphs. This lack of understanding caused them to design superficial and disconnected tasks and activities. For instance, when they addressed an objective related to drawing graphs, they merely focused on the procedural aspects (e.g., drawing it correctly). They did not consider issues such as which statistical questions were sought to be answered or how data would have been collected. The fact that the pre-service teachers did not put the process of making statistics into centre while structuring their lessons, and that they focused on operational issues such as creating graphs and making statistical calculations are parallel to the findings that have been reported and emphasized in the literature (Chick & Pierce, 2008; Garfield & Ben-Zvi, 2008; Heaton & Mickelson, 2002; Ijeh, 2012; Lee et al., 2014; Reston et al., 2006). It is stated that even experienced teachers structure their lessons by focusing on

statistical calculations (Quintas et al., 2014). The prior experiences with learning and doing statistics that were not structured in a way to support the statistical process might have paved the way for the emergence of such results (Arı, 2010).

Teachers' and pre-service teachers' lack of understandings related to doing statistics have been widely emphasized by prior research (Burgess, 2007; Espinel et al., 2008; Hannigan et al., 2013; Koleza & Kontogianni, 2016; Sorto, 2004). A number of studies have found that pre-service teachers and teachers disregarded the context when working with data sets and deciding on the appropriate graph type and associated the data with operational procedures (Burgess, 2002; Chick & Pierce, 2008). Likewise, in the current study, pre-service teachers demonstrated some misunderstandings and overgeneralizations related to the role of context in doing statistics which impacted their use of graphs in doing statistics. Conceptions such as *"contexts involving continuous variables are represented with line graphs"* and *"data with low frequency is represented by bar graphs, data with high frequency is represented by pie graphs."* impacted their decisions and actions when they designed and implemented lessons. These findings are in agreement with Burgess's (2007) findings which showed that pre-service teachers, who did not have a learning experience where the context is in the nature of statistics and questions are formulated according to the context, see statistics as formulas and calculations, and take certain generalizations into account when making inferences (Burgess, 2007).

The pre-service teachers' initial ideas and understandings developed gradually as they designed lesson plans, discussed about the concepts and reflected on their lesson plans and instructional implementations. In particular, they realized that doing statistics starts with a question that can be answered by collecting and analyzing data; and the question affects all components of doing statistics. The pre-service teachers' starting to put formulating questions into the centre of doing statistics became an important turning point significantly affected their conceptions related to doing and teaching statistics. For instance, while they initially viewed graphs as tools to represent data differently; they began to view graphs as tools to answer a statistical question. Such an understanding enabled them to compare and contrast different types of graphs in relation to answering particular questions. As a result, while deciding on the type of graph suitable for a data set, they took into account not only the type of the variable but also the questions addressed. Likewise, they began to think about the context of the tasks in relation with a statistical question addressed by collecting and analyzing data. Pre-service teachers also found opportunities to challenge their misunderstandings and overgeneralizations related to the role of context and type of variable as they designed and implemented the lessons. Also, the aspects of doing statistics that they initially did not consider but observed in students' work triggered the expansion of their understandings and teaching practices.

Throughout the study, we observed several instances that they transformed their understandings into teaching practices. For instance, with the understanding of the role formulated questions play in doing statistics, pre-service teachers began to evaluate tasks and context of the tasks in relation to a problem situation, a purpose or a question. They also revised their utterances (e.g., explanations, questions) in lesson plans and instructional implementations to emphasize the role of question in doing statistics. They began to create opportunities for students to think about the problem and the question

presented in a statistical situation. In addition, they brought the role of graphs as tools to answer a statistical problem to the fore and asked questions to make students think in this direction. During the study, the pre-service teachers also realized that data collection is a part of doing statistics and needs to be included in the instruction. Asking students questions about how data could have been collected could be considered as an example of transforming their understanding into their teaching practices. As they became more aware of the importance of the data collection process, they began to pay greater attention to the use of real-life data, which could improve statistical thinking (Garfield & Everson, 2009).

The changes observed in the pre-service teachers' understandings and their teaching practices could be attributed to several factors enabled by the lesson study that they participated. The literature has been pointed out that pre-service teachers' working with students is an effective tool to foster their development (Ball & Cohen, 1999; Ball & Forzani, 2009). The questions asked, explanations made and responses given by the students during the instructional implementations were found to have helped the pre-service teachers transform their understandings into teaching practices. Implementations provide guidance to the pre-service teachers about the points that students might have difficulty with (Ijeh, 2012). In this study, the participants began to consider students' thinking when selecting tasks and structuring the instructional moves. For instance, when choosing the context of the task, they considered situations that may cause over-generalizations (e.g., votes are represented by pie graph). They began to take into account possible student reactions, conceptions, or mistakes. Experiences in real classroom implementations, especially unexpected situations, emerged during the implementations, and discussions and reflections on these experiences enabled them to reconsider their assumptions about students' thinking.

Research suggests that classroom activities should be designed in such a way as to put a great emphasis on the process of doing statistics (Garfield & Everson, 2009; Green & Blankenship, 2013; Heaton & Mickelson, 2002; Visnovska & Cobb, 2019). In the current study, a discussion was conducted with the pre-service teachers about the components of doing statistics before the lesson study. Yet, it was observed from the initial implementations that such a discussion was not very meaningful for them. When they started to work on instructional practices, the discussions conducted at the beginning became more meaningful to them. When they designed lesson plans, conducted instructional implementations and talked about these practices, they became personally involved in the process and gained a greater awareness of doing statistics. Namely, their personally experiencing of the process by means of designing and conducting instructional implementations in both the university and real classroom environments can be seen as an important key point supporting the development of the pre-service teachers' understandings and teaching practices.

Evaluation of the lessons is emphasized to be one of the important factors allowing teachers and pre-service teachers to see the deficiencies in their lessons and compensate for them (Hiebert & Morris, 2012; Santagata et al., 2007). In this study, the pre-service teachers' discussion in groups and discussions conducted in the university and real classroom environments after their presentations to overcome the problems they experienced can be seen as other key points. These discussions facilitated the pre-service teachers to take different perspectives and allowed them to share information as

well. For example, the question asked by the expert, "*Why do you draw a pie graph? You need to think about this*." encouraged the pre-service teachers to think about their knowledge related to the formulation of questions. Thus, such experiences can be seen as another important factor triggering information exchange among them (Guskey, 2003; Hiebert et al., 2003) in developing understandings and teaching practices.

When all the lesson study cycles are evaluated together, it is seen that though the changes mentioned above were observed in the pre-service teachers' understandings, they still demonstrated difficulties in producing effective lessons for teaching graphs. For instance, they were observed to have difficulties designing tasks with meaningful problem situations or statistical questions, associating the data collection and interpretation of the results with the questions formulated. These findings support literature that the transition of subject knowledge into pedagogical content knowledge requires considerable time and effort and changes are not immediate (Friel & Bright, 1998; Fullan, 1991). It can be said that throughout the lesson study process, the authors did not present an instruction or intervene in planning activities. The pre-service teachers received feedback only after the implementation of the lesson plans in the university and in the real classroom settings. A more structured lesson study process along with an instruction focused on teaching graphs can make a greater contribution to the development of knowledge. Due to the difficulties involved in planning both the university and real classroom applications, the number of the participants was kept limited, which is another limitation of the current study. In addition, limited physical and technological conditions in real classroom settings did not allow the inclusion of technology in the instructional implementations. This can also be seen as another limitation of the study.

It can be thought that this study contributes to the literature by revealing the development of pre-service teachers' understandings of doing statistics. In this regard, the current study is believed to guide researchers in developing content for both in-service and pre-service teacher training programs. The results of this study indicate that doing statistics should be put into the center of the content of the courses. Moreover, the programs should allow pre-service teachers to carry out activities and practices to make sense of this process. Components of lesson study such as planning, implementing, revising and evaluating contributed to the development of the pre-service teachers' understandings. In particular, implications in university classrooms and real middle school classrooms support learning in theory and practice. At this point, attention should be paid to school-university cooperation and curriculum developers are suggested to design courses that will allow pre-service teachers to practice in real school environments.

Statement of Responsibility

Nadide Yılmaz; conceptualization, methodology, data collection validation, investigation, resources, data collection, design of research process, writing - original draft, writing - review & editing. İ. Elif Yetkin Özdemir; conceptualization, methodology, validation, writing - original draft, writing - review & editing, visualization, supervisior.

Conflicts of Interest

There is no conflict of interests for this study.

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Developing Co-constructivism Scale at Science Courses for Secondary School Students*

Ortaokul Öğrencileri için Fen Bilimleri Dersinde Birlikte Yapılandırmacılık Ölçeğinin Geliştirilmesi

İjlal OCAK** **Nilda HOCAOĞLU*****

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ABSTRACT: According to co-constructivism theory, learning is a social activity. Students are expected to find many opportunities at Science lessons to construct their collective culture and co-construct their culture since science lessons tend to collaborate. This study aims to develop a scale that measures the co-constructivist environment at 7th and 8th Grades science courses. For this reason, the scale developed by the researchers has been applied to 238 7th and 8th grade students. Exploratory Factor Analysis has been applied for 47 items. As a result of factor analysis, 20 items have been omitted, and the remaining 27 items have been grouped into five factors. These factors explain 64.371% of the total variance. Cronbach Alpha value of the scale is .950. The values of item-total and item-remaining correlation are significant (p<.01). Moreover, the item discrimination value obtained from the difference between mean points of bottom and top 27% of the groups is significant. As a result of confirmatory factor analysis, goodness of fit indexes are seen to be acceptable (RMSEA=.084; AGFI=.70; SRMR=.064; CFI=.91; NNFI=.09, χ^2/sd=1.93). It was found that the qualitative results mostly coincided with the results of the quantitative study.

Keywords: Co-constructivism, science education, scale development, exploratory factor analysis, confirmatory factor analysis.

ÖZ: Birlikte yapılandırmacılık teorisine göre öğrenme sosyal bir aktivitedir. Fen derslerinin doğası iş birliği eğilimi gösterdiğinden, öğrencilerin Fen derslerinde kolektif kültürlerini oluşturmak ve kendi kişisel kültürlerini birlikte oluşturmak için birçok fırsat bulmaları beklenir. Bu çalışma, 7. ve 8. sınıf Fen derslerinde birlikte yapılandırmacılık ortamını ölçen bir ölçek geliştirmeyi amaçlamaktadır. Bu nedenle araştırmacılar tarafından geliştirilen ölçek, 238 7. ve 8. sınıf öğrencisine uygulanmıştır. 47 maddeye Açımlayıcı Faktör Analizi uygulanmıştır. Faktör analizi sonucunda 20 madde çıkarılmış ve kalan 27 madde 5 faktörde gruplandırılmıştır. Bu faktörler toplam varyansın %64.371'ini açıklamaktadır. Ölçeğin Cronbach Alpha değeri .950'dir. Bu bulgular ışığında ölçek geçerli ve güvenilirdir. Madde-toplam ve madde-kalan korelasyon değerleri anlamlıdır (p<0.01). Ayrıca grupların %27'lik alt ve üst puan ortalamaları arasındaki farktan elde edilen madde ayırt etme değeri anlamlıdır. Doğrulayıcı faktör analizi sonucunda uyum iyiliği indekslerinin kabul edilebilir olduğu görülmektedir (RMSEA=.084; AGFI=.70; SRMR=.064; CFI=.91; NNFI=.80, χ^2/sd=1.93). Nitel sonuçların da nicel çalışmanın sonuçlarıyla çoğunlukla örtüştüğü bulunmuştur.

Anahtar kelimeler: Birlikte yapılandırmacılık, fen eğitimi, ölçek geliştirme, açımlayıcı faktör analizi, doğrulayıcı faktör analizi.

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** Prof. Dr., Afyon Kocatepe University, Afyonkarahisar, Turkey, iocak@aku.edu.tr, https://orcid.org/0000-0001-6976-5747
*** *Corresponding Author*: Lecturer, Afyon Kocatepe University, Afyonkarahisar, Turkey, nhocaoglu@aku.edu.tr, https://orcid.org/0000-0002-3456-095X

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The educational constructivism of personal diversity emphasizes the individual creation of knowledge and the construction of concepts. This stream can be traced back to the Kantian theories of Piaget's cognitive development. The educational constructivism of social variety emphasizes the importance of the group for developing and confirming ideas. This has its roots in Vygotsky's work in linguistics and language acquisition and is seen, for example, in Rosalind Driver's later publications (Matthews, 1998, p. 3). Constructivism's perspectives on the role of the individual, the importance of meaning-making, and the learner's active role are the very factors that make theory attractive to teachers. Teachers are usually very conscious of the role of prior knowledge in student learning. They acknowledge that the students are not empty slates waiting to be filled with knowledge. Instead, students bring a wealth of previous experiences, knowledge, and beliefs to develop new knowledge (Jones & Brader-Araje, 2002). For Piaget, the construction of knowledge is achieved when new knowledge is actively assimilated and integrated into existing knowledge. Social constructivism avoids the idea that individual cognition is the only driving force behind the construction of knowledge (Hyslop-Margison & Strobel, 2008). According to radical constructivism, knowledge is in the heads of the people. The thinking individual is left with no choice but to construct what he or she understands from personal experience (Jones & Brader-Araje, 2002).

Co-constructivism aims to unite two separate concepts: constructivism and sociogeneticism, seen as opposite domains. Contemporary developmental psychology includes two main oppositional ideas, which causes the emergence of the concepts like co-constructivism. First, there is a contrast between these assumptions; one is that the psychological functions are given assets, and the other is that the organisms construct these functions throughout their lives. Constructivism emerges from this ontological assumption as an opposite solution. It is asserted that psychological functions are constructed rather than pre-existing assets (Valsiner, 1996). The focus here is on the axiomatic declaration of the origin of these functions and the nature of their functioning. From the standpoint of their current existence, the two perspectives converge. These viewpoints can be traced from this example: A child's solving of a puzzle can be interpreted as the child's construction of a solution (as a perspective of constructivism) or as the child's finding a solution (as a non-constructivist view since the assumption of the pre-existing solution). Through constructivism, the child tries to develop or make up the solution. In contrast, through the perspective of the non-constructivist view, the child tries to find a solution under the assumption of the solution that already exists (Valsiner, 1996).

Secondly, how psychological functions exist causes individual and social (inter-individual) opposition (Valsiner, 1996). Two widespread opinions on society relationship (individual affecting society and society affecting person) have led to the views of social scientists. Both models have prevented conceptualization of psychology for the mutuality of the relationship between individuals and society. Many psychological concepts that can start from phenomena of mutuality as stated intuitively (for example, the idea of attachment or bonding that causes requires reference to a relation) are translated into theoretical and methodological dimensions of psychology into assets that belong to the individual or the environment (Valsiner, 1996). For example, the concept of attachment has resulted in an empirically determinable property

of the child with the initial focus on a relationship irreversibly lost in the translation process (Valsiner, 1996). Therefore, the co-constructionist view tries to put the individual and the society together because of mutuality and interdependence.

The concept of co-constructivism sees individual uniqueness as proof of the social origins of the human psychological ontogeny (Branco & Valsiner, 1997). It combines personal locations of psychological functions with their social origins. Co-constructivism does not aim to distinguish the social and the individual within the psyche. Instead, it seeks to find opportunities to conceptualize these two sides together mutually and systematically. The individual's psychological functions are personal in their present case, but they are social in their origins and interdependent with their social surrounding to sustain themselves (Valsiner, 1996). According to Speed (1991), reality is constructed or negotiated through the ideas of individuals or groups in the sense that different forms are emphasized. These thoughts are generated from the social groups in which people join.

The co-constructionist line in theory building may appear to be a recent development, yet this is only an illusion based on the ignorance of the history of psychology. All of the great sociogenetic thinkers in the past advocated for some form of co-constructionist thinking. The co-constructionist flavor of their work is only overlooked when their contributions are forced into artificial restricting categories of cognitive or social emphases. One of the first empirical demonstrations of the co-constructivist process is Frederic Bartlett's work. Sherif's (1936) renowned investigations of how social norms are collaboratively produced in social group settings are an empirical extension of co-constructivist views. A significant role of the inventor of the co-constructivist idea belongs to James Mark Baldwin, whose impact upon the work of both Piaget and Vygotsky was significant. The sociogenetic interests in contemporary psychology and education have mediated much of the interest in Vygotsky's heritage. As a result, the person-centeredness of his approach has been neglected. Internalization is a crucial idea in his sociogenetic theory. Using sign systems, the developing individual actively converts inter-personal experience into an intra-personal form. Semiotic mediation of human psychological functions is a significant component of his philosophy, and it exists in both the inter-personal and intra-personal worlds. As a result, the dual but interdependent presence of the personal and social worlds exists and is emphasized as development progresses. He followed James Mark Baldwin's lead and developed his views in line with William Stern's (Valsiner, 1996).

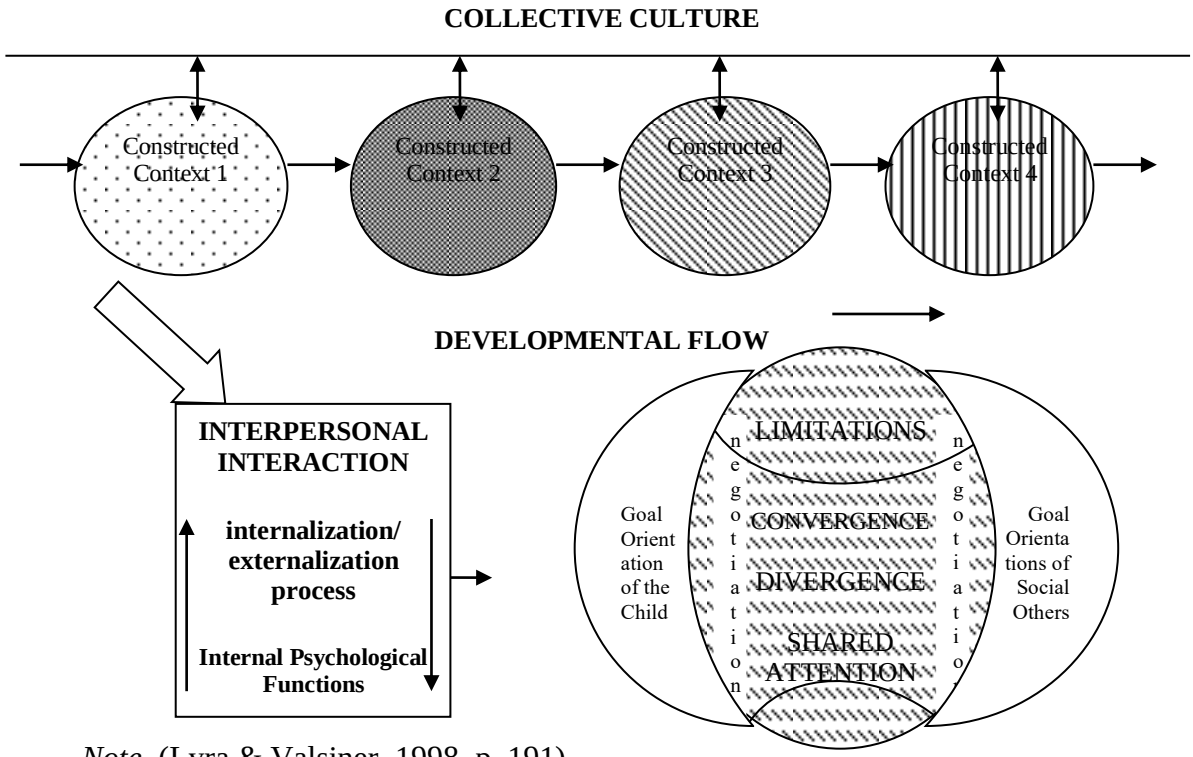
Co-constructivism is a type of sociogenetic personology (study of personal traits) (Lyra & Valsiner, 1998, p. 187). Sociogenetic thinkers point out that all or at least higher psychological functions of human beings are socially constructed. This causes the active person, who structures his/her psychological world constantly to relate it to the outside world, to retain his/her central role and the historical priority of the social world. Thus, the development of a human being is described by developing his/her psychological system and the common constructing with the goal-oriented social others who offer social suggestions to him/her (Geert et al., 1994, p. 249-250). The sociogenetic approach of this theory places a special emphasis on the uniqueness of individual people in terms of being culturally bound. In other words, people are micro-level (personal-cultural) parts of a macro-level entity (collective culture). The

relationship between the two levels can be defined as bidirectional cultural transformation. On the one hand, collective culture occurs in the field of common meanings of the social group. On the other hand, each individual structures his/her own collective culture and actively structures his/her culture together (Lyra & Valsiner, 1998, p. 187). Therefore, personal and collective culture interacts inseparably.

Learning is a constructive process and social activity, so students should not be seen as solo learners. Instead, they interact with each other and shape their learning through collaboration. Therefore, personal development is not based on isolation while constructing knowledge; rather, its basis comes from co-construction in a cultural environment through a social way (Reusser & Pauli, 2015). Students are common constructors of their culture and contribute to the innovations of collective culture. The developing human is an active and constructive individual, acting in a highly heterogeneous environment provided by collective culture. The heterogeneity of collective culture is found mainly in the semiotic dimension of social reality. The semiotic knowledge structuring of an active person, including collective cultural suggestions, gives a dynamic form to the developmental process. Collective culture establishes (explicitly or implied) numerous physical and semiotic forms. In the process of co-constructivism, the individual constructs his/her self in detail and reconstructs some aspects of the macro-level environment when the circumstances allow (Lyra & Valsiner, 1998, p. 187-188). Critical interaction and microgenetic analysis emphasize how human beings' interactions with each other and with objects in their environment their learning and change processes. They automatically co-construct larger social and cultural structures, relations, and processes (Philip & Gupta, 2020).

Figure 1

Co-constructivist Description of Child Development through Constructed Contexts



Note. (Lyra & Valsiner, 1998, p. 191).

Figure 1 represents the developmental flow of a child while he/she is moving towards successfully constructed contexts. Contexts can overlap, but in some cases, they transform to each other dynamically over time. For example, being at a museum or in a library creates a kind of overlap in these constructed contexts. How students interact with these spaces may have divergence in terms of students' motivation. Boys may demonstrate rude behavior among their friends but being at a museum or in a library requires behaving in a certain manner. Boys have to negotiate to reach convergence because of the limitations, such as the rules of being at a museum. Constructed contexts naturally consist of parts of collective culture. Still, they are open to innovations created by co-constructivist processes that arise from concrete social interactions (Lyra & Valsiner, 1998, p. 192). This developmental flow can happen both in a formal or informal context since these contexts can overlap. For example, the interaction among children can occur in a playground or a scientific contest. Successfully constructed context may indicate the situation of reconciliation through concrete social interactions. The content of each structure presents certain limitations arising from social participation rules and expectations. Participating individuals continuously reconcile with their goal orientations at the intersection of individuals' interactions and internal psychological orientations when the internalization-externalization processes actively coordinate the behavior of individuals. Thanks to the dialectical movements that manage such processes, the child's perspective co-constructs a synthesis from interests and meanings. Reconciliation processes constantly occur during the sequence of goal orientations. Limitations are determined by how the context is constructed and created by the goal orientation of the individuals who interact with each other (Lyra & Valsiner, 1998, p. 192). Hence, it can be said that limitations are shaped by both the constructed contexts and the goal orientations.

The child moves with dynamic interaction around him/herself through co-constructivist interactions. As the child grows, such contexts and the nature of social others playing an essential role in the child's emotional-sociocognitive development will also change. The child plays an active role in the process of developing his/her culture. However, it is embedded in the cultural canalization process, put forward by the constructed contexts. The child uses the elements of shared culture as an input to develop his/her culture. It creates a personal type that changes as internal psychological orientations on this input. As shown in Figure 1, the mutual co-construction between personal and collective culture emerges through internalization-externalization (Lyra & Valsiner, 1998, p. 192). During this process, interpersonal interaction has a significant role since it contributes a lot to cultural forms.

Culture can be seen as an organizational form that directs the next state of human structure. The focus of co-construction leads to restructuring hierarchical organization within structures (Geert et al., 1994, p. 279-280). It is crucial to structure a goal-oriented individual who acts in consciously constructed surroundings and interacts purposefully with other people (Valsiner, 1996). The process of human development is dynamically goal-oriented. Accordingly, any participant can create a goal, try to achieve it, change previously targeted goals, or abandon these goals altogether. Being goal-oriented does not mean that goals can be maintained statically. This only emphasizes the future constructivist orientation of psychological processes (Geert et al., 1994, p. 279). In other words, culture has a crucial role in the developmental flow of the human being,

and human development is a goal-oriented process. In such an environment where the people interact with others purposefully, constructing people who have motivation is a significant aim of co-constructivism. In this perspective, culture and motivation are embedded since there should be a negotiation between the child and the others' goal orientation.

Instead of passively receiving information, children interpret their experiences genius by reorganizing their mental structures in increasingly difficult ways to make sense of their worlds. According to symbolic interactionism and sociocultural theory, learning occurs through social activity and is mainly hidden in society and society's knowledge, perspective, and beliefs. People structure their knowledge through personal experiences and conversations with others and social experience and interaction (Reusser, 2001). Thus, personal development and acculturation are not to be socially alone in structuring knowledge but to structure it together in the cultural and social field. In plenty of settings, many learning is a social activity and a cultural sharing. The child develops his/her knowledge within other individuals who feel belonging to a culture. From this perspective, knowledge does not stand alone in every individual's mind. It is dispersed among individuals who have common interactions and conventions. Co-constructivism can be seen as an adult + child interaction or an interaction between a child and someone more capable. From the cognitive point of view, co-constructivism can be seen as a common understanding of two or more individuals as collaborators or a solution to a problem. At the heart of the concept of co-constructivism lie two co-existing activities. These are solving the problem in a collaborative way and structuring and maintaining a common problem area. Co-constructivism requires individuals to acquire, maintain and update a degree of mutual understanding. The best way to support co-constructivist learning is about designing effective collaborative learning environments. Teachers' role in co-constructivist classrooms is to guide students and help them engage in authentic and task-oriented, constructed social interactions (Reusser, 2001).

The majority of studies focus on the ideas of the students and teacher candidates about the constructivism approach. There are also a few scale development studies measuring the constructivist learning environment (e.g. Ağbuba, 2010; Bay et al., 2010; Bukova-Güzel & Alkan, 2005; Evrekli et al., 2009; Yeşilyurt, 2012). In this context, the most used scale has been CLES (Constructivist Learning Environment Questionnaire) by Taylor and Fraser (1991). The scale has been updated and developed many times (Taylor et al, 1994). This scale was adapted to Turkish by Küçüközer et al. (2012). Tenenbaum et al. (2001) focused on seven categories in the constructivist learning environment scale they developed. Fer and Cırık (2010) studied this scale's language equivalence, validity, and reliability and adapted it to Turkish. Arkün and Aşkar (2010) developed a 7-point Likert-type scale to assess the constructivist learning environment to obtain the opinions of university students on the face-to-face constructivist learning at the higher education level. So, the developed scales aim to measure constructivist learning in general. However, none of these studies addresses co-constructivism, especially in science courses at secondary school education.

It has been proven by many studies that preparing learning environments in which students will learn concepts in a meaningful way, rather than encouraging memorization, is much more effective in learning science subjects. The co-constructivist

approach aims to foster active participation, intense interaction, and culture sharing through social motivation. The focus of science teaching is to enable the students to recognize nature and the environment. The students should acquire unique knowledge about nature and structure them in their minds to achieve the aims of science learning. To construct the facts about nature, they must observe, conduct experiments and interact with nature. The co-constructivist learning environment allows all these aims of Science teaching. Social constructivist science teaching aims to develop students' scientific thinking skills and, in this way, share, agree, and discuss with their classmates. The learning environment, content, and objectives of Science teaching are designed accordingly. It is accepted that knowledge is acquired in a social environment in constructivist science teaching. If the students work in groups, they share their knowledge with their friends and form a discussion environment; if necessary, they analyze or review this information by conducting experiments. Students build their knowledge and understandings depending on prior information and the sociocultural setting they find themselves. In these sociocultural settings, they are expected to connect learning with everyday contexts. They are expected to reveal current ideas as well as alternative ones (Eastwell, 2002).

The purpose of the scale is to find out whether there are any applications of co-constructivism in Science courses in terms of the interaction and relationship between student and student. One of the basic skills of the Science curriculum is cultural expression and awareness. In accordance with this skill, the students are supposed to fully understand their own culture, respect cultural differences, and have a positive attitude towards them **(**MEB, 2018, p. 6). From this point of view, co-constructivism gains importance in Science courses, as well.

Method

Multilevel mixed design, one of the mixed methods, has been used since the study aims to develop a scale to measure co-constructionist environment in the 7th and 8th Grade Science courses. As the study aims to develop a scale for Science courses, 7th and 8th Grade students' opinions about the co-constructionist environment of Science courses will be more suitable since they have been learning science for one or two years at the secondary education level. Multilevel mixed designs can be either parallel or sequential designs. In these designs, mixing happens through multiple levels of analysis, as quantitative or qualitative data are analyzed and combined to answer related aspects of the same research question or related questions (Teddlie & Tashakkori, 2009, p. 136). In this study, literature research and interviews were carried out before writing the items of the scale. In this respect, a parallel design was used while collecting data from literature and interviews. Quantitative data were collected for factor analysis, and interview questions were created from the scale in terms of the related aspects of the same research to enhance the validity and reliability of the scale.

Participants

The study group of this research, who attended the pilot test, consists of 136 females (57.1%) and 102 males (42.9%), a total of 238 students studying at three different secondary schools in Afyonkarahisar. 137 of the students are 7th Grade students, and 101 of them are 8th grade students. The sampling method and the features of samples used are given in Table 1.

Table 1

Sampling Method and Samples

Data Collection Tool	Sampling Method	Samples
Interview Form	Convenience Sampling	5 secondary school students (7th and 8th Grades)
Literature research	Convenience Sampling	Books and articles
Pre-test application (for item comprehensibility)	Convenience Sampling	10 secondary school students (7th and 8th Grades)
Pilot test application (for item analysis)	Convenience Sampling	238 secondary school students (7th and 8th Grades)
Structured interview questions	Convenience Sampling	12 7th Grade students
Test re-test reliability	Convenience Sampling	68 secondary school students (7th and 8th Grades)

According to Table 1, secondary school students were asked open-ended questions about co-constructivism related to Science courses to create the item pool. Open-ended questions were asked to five students studying in 7th or 8th Grade. Secondly, the literature on co-constructivism was reviewed to write items related to the scale. The theoretical background about co-constructivism was obtained from the sources, and key concepts have been determined. After creating the item pool, ten secondary school students gave feedback on the comprehensibility of the items. After making necessary corrections, the 47-item scale was applied to 238 7th and 8th grade students in three different secondary schools in Afyonkarahisar in the first term of 2017-2018. To strengthen the validity and reliability of the scale, interview questions were prepared in line with the factor analysis findings, and they are asked to twelve 7th grade students.

Ethical Procedures

Ethical approval and written permission were obtained from the Social and Humanities Scientific Research and Publication Ethics Board of Afyon Kocatepe University in Turkey with the decision dated 22.02.2021 and numbered 2021/111. Ethical rules were followed at each stage of the research. The participants took part in the study voluntarily.

Findings

Development of the Scale

This scale, which was developed to evaluate the co-constructivist environment in the Science courses, is 5 point Likert type. Likert-type scales are developed by using the item analysis approach. A particular item is evaluated in the item analysis approach based on the differences between high and low score items. Items that best meet such a difference test are included in the final measurement tool. Thus, Likert-type scales contain many sentences expressed from the most positive to the most negative attitude towards the given subject (Kothari, 2004, p. 84). According to the suggestions of

Carpenter (2018) with regard to the development of a scale, the steps below were followed:

Theory and Research

The structure and meaning of a construct should be pre-specified by theory. According to the literature review and conceptual definitions, researchers analyzed the items of each factor to determine the most suitable concept label such as co-design, co-work, collaboration, culture sharing, interaction, common knowledge, relationship with real life. Potential dimensions and items were determined by considering the objectives of the 6th and 7th Grade Science curriculum. To create and validate items, researchers conducted a qualitative study. Through interviews, secondary school students about the activities related to co-constructivism were asked open-ended questions related to Science courses. An item pool consisting of 47 items was created for this scale. Twenty-six of them included the objectives of the 7th Grade curriculum. Four of them included the objectives of the 6th Grade curriculum. Seventeen of them were created through the common subjects of the 6th and 7th Grade curriculum. The item pool was created considering the interaction and relationship between student and student, one of the co-constructivism dimensions. The other dimensions are the relationship between mother and child or student and teacher or learning in teams. Each item was written depending upon the literature and the 6th and 7th grade Science curriculum objectives. 6th Grade Science curriculum covers the subjects as follows: Solar system and eclipse, systems and health in our body, force and motion, matter and heat, sound and features, conduction of electricity whereas 7th Grade Science curriculum covers the subjects such as Solar system and beyond, cells and divisions, force and energy, pure substance and mixtures, the interaction of light with matter, reproduction, growth, and development in living things, electrical circuits. The items in the scale were tried to written considering each subject in the curriculums. Open-ended questions were asked to five students studying in 7th or 8th Grade.

Interviews and expert feedback are critical in the item generation and dimension identification process. Expert feedback was used for item refinement to eliminate complex wording/language and vagueness in questions/biased questions. After the item pool was created, 59 items were evaluated by three experts to have their opinions. These experts examined the items whether they were written according to the objectives stated in the Science curriculum. 11 items that were not suitable for the 6th and 7th Grade Science curriculum were removed from the scale, and six misunderstood items were corrected. Items were marked as “I always do” (5 points), “I often do” (4 points), “I occasionally do” (3 points), “I rarely do” (2 points), and “I never do” (1 point). The high score obtained from the scale indicated that the respondent agrees with the items. In other words, getting a high score from the scale indicated that the participant agrees that a co-constructivist environment exists in Science courses, while getting a low score means the opposite of this view.

To refine questionnaire questions and the design of the scale, a pre-test was applied to a group of ten secondary school students to identify problems in terms of language and expression. After this pre-test, one unsuitable item was removed from the scale. Then, the remaining items were checked for content validity, showing a basis for

the literature, and the scale was applied to 238 7th and 8th Grade students in three different secondary schools in Afyonkarahisar for pilot testing.

Determine Sampling Procedure

In this step, researchers decided on an appropriate sample size. Gorsuch (1983) states the required sample size for factor analysis as follows: "The minimum ratio is 5 individuals for each variable" (Thompson, 2004, p. 24). The sample size in this study is suitable for factor analysis (n=238).

Examine Data Quality

Researchers checked for missing data and deleted a few cases since most responses contained missing data or only the same answer.

Verify the Factorability of the Data

Bartlett test is the most useful way to determine whether variances are equal (Singh, 2007, p. 102). Kaiser-Meyer-Olkin (KMO) coefficient and Barlett sphericity test were used to determine the suitability of the data for factor analysis (Büyüköztürk, 2012, p. 126). Accordingly, the KMO result of the items being .95 and Barlett test value being .00 significant (x^2=7886; sd=1081; p<.01) showed that the data were suitable for factor analysis. If KMO is higher than .70, it indicated that a sufficient number of samples were available for each factor (Leech et al., 2005, p. 80).

Conduct Exploratory (Common) Factor Analysis

Exploratory factor analysis was conducted to determine the construct validity of the scale. The findings of exploratory factor analysis were presented orally by the researchers (Ocak & Hocaoglu, 2018a). Exploratory factor analysis aims to determine the number of common factors affecting a group of measures and the strength of the relationship between each observed measure and factor (DeCoster, 1998).

Select Factor Extraction Method

In this study, principal component analysis was used as a factoring technique to facilitate interpretation.

Determine the Number of Factors

To determine the factor number, eigenvalues greater than one rule were taken into account. Items with an Eigenvalue (initial eigenvalue) greater than 1.00 were included in the scale. As in Table 2, 5 factors explain 64.371% of the total variance. This value is above 41%, which is the acceptable value (Kline, 1993).

Table 2

Explanation of the Total Variance of the Co-constructivism Scale

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Item	Total	Explained Variance	Total Variance	Total	Explained Variance	Total Variance	Total	Explained Variance	Total Variance
1	11.857	43.914	43.914	11.857	43.914	43.914	4.092	15.156	15.156
2	1.774	6.569	50.483	1.774	6.569	50.483	3.977	14.730	29.886
3	1.392	5.157	55.640	1.392	5.157	55.640	3.668	13.587	43.473
4	1.233	4.566	60.206	1.233	4.566	60.206	3.111	11.521	54.994
5	1.125	4.165	64.371	1.125	4.165	64.371	2.532	9.377	64.371
6	.841	3.115	67.486						
7	.816	3.023	70.509						
8	.673	2.494	73.002						
9	.646	2.392	75.394						
10	.616	2.281	77.676						
11	.585	2.168	79.844						
12	.567	2.099	81.942						
13	.493	1.825	83.767						
14	.469	1.737	85.503						
15	.451	1.671	87.174						
16	.443	1.639	88.814						
17	.394	1.459	90.273						
18	.380	1.407	91.679						
19	.355	1.316	92.996						
20	.347	1.284	94.279						
21	.297	1.099	95.379						
22	.275	1.019	96.398						
23	.248	.918	97.315						
24	.209	.776	98.091						
25	.191	.706	98.797						
26	.169	.625	99.423						
27	.156	.577	100.000						

According to Table 2, the variance explained by the 1st factor is 43.914%; by the 2nd factor is 6.569%; by the 3rd factor is 5.157%; by the 4th factor is 4.566% and by the 5th factor is 4.165%.

Rotate Factors

The rotation process was performed using the varimax method because the varimax method examines the columns of the factor loadings matrix to achieve a meaningful structure. This method also ensures that fewer variables make the most factor variances (Tavşancıl, 2010). In Table 3, the rotated components matrix belonging to the Co-constructivism scale is given.

Table 3

Rotated Components for the Co-constructivism Scale

	Components				
Items	1	2	3	4	5
I prepare a project with my friends on the development of the chemical industry in Turkey.	.697				
I design a tool with my friends for reducing the effect of water resistance.	.689				
I design a tool with my friends for reducing the effect of air resistance.	.689				
I share with my friends local naming for organs given in different regions of Turkey.	.650				
I research with my friends the most frequent system diseases (circulatory system, digestive system, etc.), which are seen in different regions of Turkey.	.600				
I design an original lighting system with my friends.	.595				
I discuss with my friends about heat insulation of the buildings in terms of family and country economy.		.741			
I research with my friends the precautions related to the stove and natural gas poisoning.		.740			
I prepare a presentation with my friends on domestic and liquid waste.		.686			
I prepare a presentation with my friends on the importance of heat insulation of the buildings.		.684			
I prepare a presentation with my friends on the importance of social solidarity for organ donation.		.632			
I prepare a presentation with my friends on the importance of Green Crescent.		.603			
I discuss with my friends the effect of water resistance in real life.			.742		

I discuss with my friends the effect of air resistance on the design of different vehicles.	.718		
I discuss with my friends the effect of air resistance in real life.	.711		
I discuss with my friends the effect of water resistance on the design of different vehicles.	.678		
I give examples of the effects of air resistance from my surrounding.	.613		
I discuss the examples I gave about kinetic energy with my friends.	.466		
I associate the relation between cell-tissue-organ-system-organism with another topic in real life.		.766	
I discuss with my friends the relation between cell-tissue-organ-system-organism by giving examples from current issues.		.716	
I share with my friends the idioms about our culture on the concepts of mass and weight (e.g., comparing the weight of 1 kg gold and 1 kg cotton)		.676	
I give examples of changing cell structures with the development of the microscope.		.611	
I discuss with my friends about organ donation in terms of the importance of social solidarity.		.564	
I give examples about recyclable items on home waste.			.827
I give examples of non-recyclable items on the home waster.			.750
I share with my friends examples of a homogeneous mixture.			.584
I identify the factors affecting the dissolution rate by conducting an experiment with my friends.			.463

In Table 3, the factor loads of 27 items in the scale vary between .46 and .82.

Retain and Delete Items Based on a Priori Criteria

Factor loads less than .30 are considered low, while those higher than .40 are considered high (Leech et al., 2005, p. 83). Items whose factor loads are less than .40 have been considered to be omitted. However, since there is no factor load lower than .40, the item cannot be removed with this method. The items should have a high load value in one factor and a low load value in the other. The difference between two high load values is expected to be at least .10 (Büyüköztürk, 2012, p. 124). In this study, this was also taken into account when determining the factors. Accordingly, 20 items (item 27, 42, 35, 43, 38, 22, 30, 41, 18, 29, 7, 21, 19, 31, 11, 28, 37, 10, 23 and 9) were omitted. After the items were removed, the scale became a 5-factor and 27-item scale.

Present Results

The Cronbach Alpha value of the scale is α=.950. If this value is .70 or higher, it is an indicator that the test scores are reliable (Büyüköztürk, 2012, p. 171). The test-retest reliability was also examined to see the reliability based on score stability over time with 68 participants. The result is r=.932. It can be said that the scale is reliable since the result is close to 1.

According to Table 3, factors are named based on the content of the items. The 1st factor was named "collaborative design". When the items included in the 1st factor are examined, it is understood that two or more individuals came together to work collaboratively or solve problems. For example, when the items like "I prepare the project with my friends", "I design a tool with my friends", "I do a research with my friends" are taken into account, it is seen that students come together and try to solve the existing problem by combining their knowledge, skills and abilities and co-construct their knowledge. The concept of co-constructivism means that individuals solve a common problem together and establish mutual understanding. The 2nd factor was named "collaborative work". The items in this factor are generally expressions such as "I prepare a presentation with my friends," which include group work and aim for students to learn together. For this reason, the 2nd factor was named "collaborative work". The 3rd factor was named "social experience and interaction". The items in this factor are related to the behaviors in environments that require more interaction and where students will experience sociality. Students' discussing a topic with other students requires interaction. The 4th factor was named "sharing culture". The items in this factor are mostly related to giving examples of culture (example of the relationship among cell-tissue-organ-system-organism), cultural sharing (expressions about mass and weight), and explaining the situations caused by the culture (social importance of organ donation). The 5th factor was named as "relating with real life". When the content of the items in this factor is examined, giving examples of recyclable or non-recyclable items causes students to connect with real life and find real examples.

In Table 4, the total correlation values of the items, item remainder correlation values, and t-test results of 27% lower and upper groups are given.

Table 4

Item Analysis of the Co-constructivism Scale (Validity-Reliability Results)

Items	Varimax Factor Load	Item Total Correlation	Item Remainder Correlation	t-test results of 27% lower and upper groups	*p* value
Item36	.697	.602	.636	10.409	.000
Item17	.689	.646	.678	12.508	.000
Item16	.689	.665	.695	12.553	.000
Item33	.650	.675	.705	13.955	.000
Item32	.600	.676	.706	12.293	.000
Item34	.595	.614	.649	12.686	.000

Item45	.741	.628	.662	13.418	.000
Item46	.740	.633	.667	13.402	.000
Item47	.686	.672	.702	13.645	.000
Item44	.684	.711	.738	15.526	.000
Item40	.632	.741	.765	18.463	.000
Item39	.603	.691	.721	16.721	.000
Item13	.742	.642	.674	12.628	.000
Item14	.718	.644	.676	11.354	.000
Item12	.711	.646	.678	11.730	.000
Item15	.678	.688	.718	15.082	.000
Item6	.613	.578	.614	10.708	.000
Item8	.466	.585	.622	10.305	.000
Item4	.766	.410	.456	7.063	.000
Item5	.716	.577	.614	10.616	.000
Item3	.676	.575	.611	10.826	.000
Item2	.611	.613	.647	12.060	.000
Item1	.564	.566	.603	10.476	.000
Item25	.827	.594	.631	11.148	.000
Item26	.750	.612	.648	11.910	.000
Item20	.584	.602	.637	11.091	.000
Item24	.463	.632	.664	11.684	.000

According to Table 4, item-total correlation values are between .410 and .741, and item remainder correlation values are between .456 and .765. Accordingly, it is possible to say that the items are good items since the item-total correlation coefficient $r>.30$ (Büyüköztürk, 2012, p. 171). Another way of item analysis is comparing the average scores given to each item by the extreme groups (upper group-lower group) (Tavşancıl, 2010, p. 55). The differences between the item average scores of the lower 27% and upper 27% groups created according to the total scores of the test were found to be significant ($p<.01$). This shows that the test has internal consistency (Büyüköztürk, 2012, p. 171).

In Table 5, means, standard deviation, and correlations coefficients of the sub-factors of the Co-constructivism Scale are given.

Table 5

Means, Standard Deviation and Correlations Coefficients of the Sub-factors

Factor	*N*	$\bar{X}$	*SD*	*p* value	1st	2nd	3rd	4th	5th
1st Factor	238	13.74	6.28	.000	1	.714	.653	.561	.638
2nd Factor	238	15.02	6.65	.000	.714	1	.632	.564	.660
3rd Factor	238	16.67	6.31	.000	.653	.632	1	.624	.611
4th Factor	238	14.42	5.04	.000	.561	.564	.624	1	.530
5th Factor	238	10.64	4.37	.000	.638	.660	.611	.530	1

According to Table 5, it is observed that there is a significant and moderate relationship between the factors. The correlation coefficient being between .70-1.00 indicates a high-level relationship; .70-.30 indicates a medium relationship, and .30-.00 indicates a low-level relationship (Büyüköztürk, 2012, p. 32). In Table 6, the alpha coefficients of the sub-factors of the co-constructivism scale are given.

Table 6

Internal Consistency Coefficients of Sub-Factors of the Co-constructivism Scale

Factors	Alpha
1. Collaborative Design	.850
2. Collaborative Work	.852
3. Social Experience and Interaction	.856
4. Sharing Culture	.874
5. Relating with Real Life	.868

According to Table 6, the alpha coefficient of the 1st factor is .850; the alpha coefficient of the 2nd factor is .852; the alpha coefficient of the 3rd factor is .856; the alpha coefficient of the 4th factor is .874, and the alpha coefficient of the 5th factor is .868.

Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is performed to test hypotheses or validate theories about previously accepted factors (Urbina, 2004, p. 174). The items in the factor named as “co-design” are shown as a1-a6; the items in the factor named as “collaborative work” are shown as b1-b6; the items in the factor named as “social experience and interaction” are shown as c1-c6; the items in the factor named as “sharing culture” are shown as d1-d5, and the items in the factor named as “relating with real life” are shown as e1-e4. CFA was performed by considering the answers of 134 samples. The subscale and composite scale reliability of coefficients of this model tested with CFA was calculated.

Confirmatory Factor Analysis First Level

The path diagram of the co-constructivism scale is given in Figure 2, and the t values for the latent variables to explain the observed variables are shown on the arrows. According to Schermelleh-Engel et al. (2003), if t values exceed 2.58, it is significant at the .1 level. The parameter estimates of the co-constructivism scale are significant at the .01 level. The chi-square value is 606.38, and the df value is 314. Accordingly, χ^2/df is 1.93. The fact that this ratio is less than 3 in large samples indicates that the level of compliance is perfect (Kline, 2011). RMSEA value is .084, which is an acceptable value. Values less than .07 for RMSEA indicate a good fit level (Steiger, 2007).

When the error variances of the observed variables in Figure 2 were examined, it was seen that the error variances were at an acceptable level. The explanatory properties of the items with very high error variance decrease at that rate (Çapık, 2014). In this case, even the items with the highest error variance (.92) were included in the analysis (Kline, 2011).

Figure 2

Error Variances in the Path Diagram of the Co-Constructivism Scale 1st Level

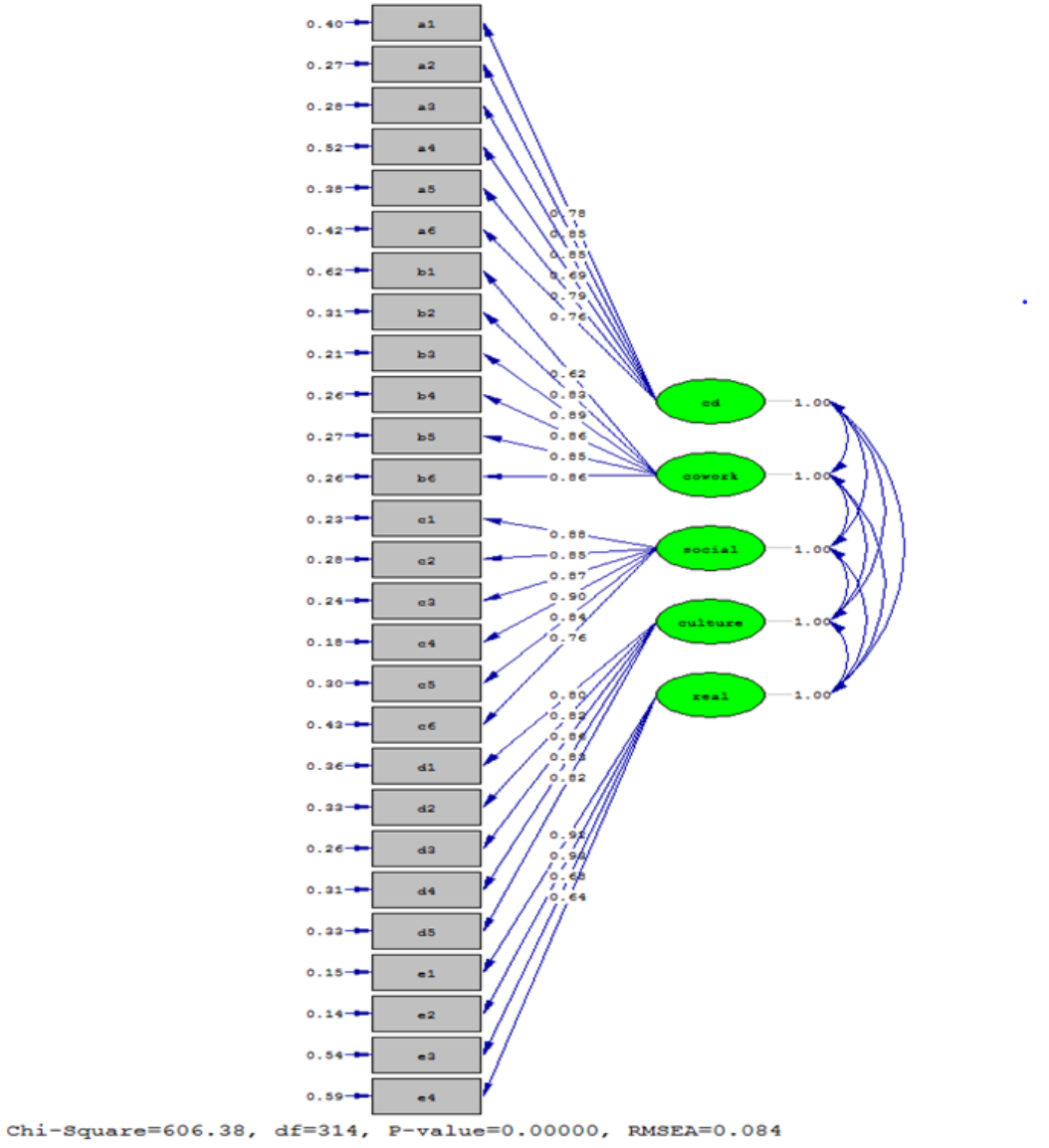


Table 7

The Goodness of Fit Indexes of the Co-constructivism Scale according to the Structural Model

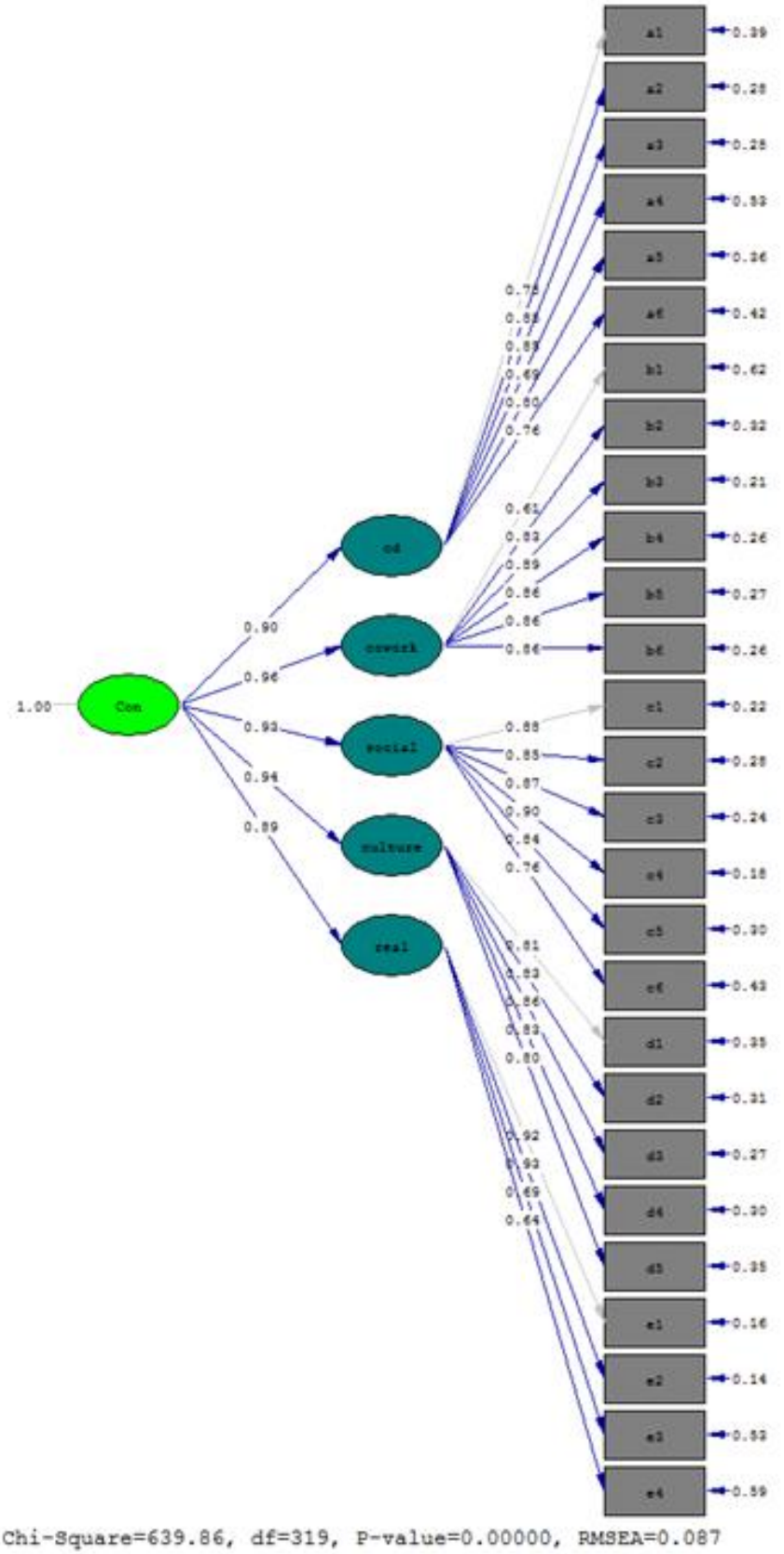
Goodness of fit indexes	Values of Co-constructivism Scale	Perfect fit values	Acceptable fit values
χ2 /df	1.93	$0 \leq \chi 2/df \leq 2$	$2 < \chi 2 /df \leq 3$
RMSEA	.084	$0 \leq RMSEA \leq .05$	$.05 < RMSEA \leq .08$
Comparative Fit Index (CFI)	.91	$.97 \leq CFI \leq 1.00$	$.95 \leq CFI < .97$
Standardized RMR	.064	$0 \leq SRMR \leq .05$	$.05 < SRMR \leq .10$
Goodness of Fit Index (GFI)	.75	$.95 \leq GFI \leq 1.00$	$.90 \leq GFI < .95$
Adjusted Goodness of Fit Index (AGFI)	.70	$.90 \leq AGFI \leq 1.00$	$.85 \leq AGFI <.90$
NNFI	.90	$.97 \leq NNFI \leq 1.00$	$.95 \leq NNFI < .97$

According to Table 7, χ^2/df ratio is 1.93. This demonstrates the value of a good fit. If this ratio is less than 3, it shows that the level of compliance is perfect (Kline, 2011). RMSEA value is .084. Brown (2015) recommends that the RMSEA value should be close to or less than .06. Accordingly, the RMSEA value is at an acceptable level. The value of CFI is .91. If this value is greater than .90, the model has an acceptable level of good fit (Kline, 2011). The value of SRMR is .064. According to Table 7, this value is also acceptable goodness of fit. GFI, AGFI, and NNFI values are seen to have poor fit according to the goodness of fit index. Although not all indexes show perfect results, the ratio of *χ2/df* and RMSEA value are among the goodness of fit index. Accordingly, these findings confirm the factor structure of the co-constructivism scale. In Figure 3, error variances of the 2nd level of the co-constructivism scale in the path diagram are given.

When the error variances of the observed variables in Figure 3 were examined, it was seen that the error variances were at an acceptable level. The explanatory properties of the items with very high error variance decrease at that rate (Çapık, 2014). In this case, even the items with the highest error variance (0.93) were included in the analysis (Kline, 2011).

Figure 3

Error Variances in the Path Diagram of the Co-constructivism Scale 2nd Level



In Table 8, the scale development process is given in brief.

Table 8

Development of the Scale

Development of the Scale	
1. Theory and Research	
a. Conceptual Definitions	The most suitable concept labels such as co-design, co-work, collaboration, culture sharing, interaction, common knowledge, relationship with real life were identified.
b. Potential Dimensions	Potential dimensions and items were determined by considering the objectives of the 6th and 7th Grade Science curriculum. Through interviews, secondary school students were asked open-ended questions related to the activities related to co-constructivism.
c. Item Pool	An item pool consisting of 47 items was created for this scale. 26 of them included the objectives of the 7th Grade curriculum. 4 of them included the objectives of the 6th Grade curriculum. 17 of them were created through the common subjects of 6th and 7th Grade curriculum.
d. Interviews and Expert Feedback	Open-ended questions were asked to five students studying in 7th or 8th Grade. The answers given to these questions guided the researchers while writing the items of the scale. After the item pool was created, 59 items were evaluated by three experts to have their opinions. 11 items that were not suitable for the 6th and 7th Grade Science curriculum were removed from the scale and six misunderstood items were corrected.
e. Pre-test application	A pre-test was applied to a group of ten secondary school students to identify problems in terms of language and expression. After this pre-test, one unsuitable item was removed from the scale. The remaining items were checked in terms of content validity, showing a basis for the literature, and the scale was applied to 238 7th and 8th Grade students in three different secondary schools in Afyonkarahisar for pilot testing.
2. Determine Sampling Procedure	
The sample size in this study is suitable for factor analysis (n=238).	
3. Examine Data Quality	
Researchers checked for missing data and deleted a few cases since most responses contained missing data or only the same answer.	
4. Verify the factorability of the data	
The KMO result of the items being .95 and Barlett test value being .00 significant (x^2=7886; sd=1081; p<.01) showed that the data were suitable for factor analysis.	
5. Conduct exploratory (common) factor analysis	
Exploratory factor analysis was conducted.	
6. Select factor extraction method	
Principal component analysis was used as a factoring technique to facilitate interpretation.	
7. Determine the number of factors	

Eigenvalues greater than one rule was taken into account.
8. Rotate factors
The rotation process was performed using the varimax method.
9. Retain and delete items based on a priori criteria
The difference between two high load values is expected to be at least .10 (Büyüköztürk, 2012, p. 124). Accordingly, 20 items were omitted.
10. Present results
The Cronbach Alpha value of the scale is α=.950. The test-retest reliability was also examined to see the reliability based on score stability over time with 68 participants. The result is r=.932. Item-total correlation values are between .410 and .741, and item remainder correlation values are between .456 and .765. The differences between the item average scores of the lower 27% and upper 27% groups created according to the total scores of the test were found to be significant (p<.01). Factors are named based on the content of the items they contain. The alpha coefficient of each factor has been calculated.
11. Confirmatory Factor Analysis (CFA)
CFA was performed by considering the answers of 134 samples. The parameter estimates of the co-constructivism scale are significant at the .01 level. The chi-square value is 606.38, and the df value is 314. Accordingly, χ^2/df is 1.93. RMSEA value is .084, which is an acceptable value.

Interview Questions

Criterion-related validity determines how well a test score may be used to infer an individual's most likely position on a measure of interest—the criterion being the measure of interest (Cohen & Swerdlik, 2009, p. 180). The validity of the test content shows to what extent the items or questions in the data collection tool represent the appropriate universe or content area. This validity requires experts to examine the tool's content (McMillan & Schumacher, 2001, p. 239-242). In this respect, a relationship may arise between the sub-factors of the scale and the interview questions. Thus, a qualitative study was conducted to increase the validity of the scale called "Co-constructivism" at Science courses.

For this reason, to support the quantitative findings previously obtained with qualitative findings, interviews were conducted with 7th Grade students regarding co-constructivism in Science courses. Interviews were conducted with twelve secondary school students selected with appropriate sampling method using a structured interview form consisting of eight questions under five main headings compromisingly with the five sub-factors of the scale. At this stage, it was aimed to measure the consistency of the answers given by the students for the "Co-constructivism" scale through interviewing them over the general theme of the sub-factors. At the same time, it was intended to determine how well the scale measures the desired situation and obtain a general framework by gaining from the students' experiences whether the applications of co-constructivism theory have been put into practice in Science courses.

Descriptive analysis was used to analyze the data. The five main questions prepared for the interviews were accepted as five main themes. Students' views were analyzed and interpreted in line with these themes. Each main part in the interview form was considered as the main theme. The answers of the students were typed and coded under the main themes. Then, researchers determined the similarities and differences of the codes and made thematic coding by bringing together the codes related to each

other. Thus, the main themes and sub-themes under them were revealed. Codes were organized under sub-themes. The following steps were followed to create the questions in the structured interview form:

To examine in detail the crucial findings that emerged in the analysis of quantitative data, the questions in the interview form were created.

- After the questions were formed, expert opinion was received from two experts to determine the correctness of the questions in terms of language and expression.

- The questions have been reshaped according to the suggestions of the experts.

- Five students were interviewed to determine the comprehensibility of the questions as a pre-application.

- Accordingly, any misunderstandings were corrected, and it was recorded how long the students' answering of the questions would take.

- After pre-application, the interview questions took their final form.

- The structured interview form consists of 8 open-ended questions forming five sub-themes. These five sub-themes reflect the sub-dimensions in the scale, and the questions are related to these sub-dimensions.

To ensure the reliability of the study, it was worked with a co-observer other than the researchers. Co-observer is a faculty member who has qualitative studies at the Department of Curriculum and Instruction. The co-observer was asked which theme and sub-theme each code belonged to for the themes and categories that emerged. The frequency and percentage values that the researchers and co-observer made for the coding were calculated to obtain the consensus agreement between the researchers and co-observer. In qualitative studies, it is a reliable method to encode more than one person and control the coding by another person (Miles & Huberman, 1994, p. 64). Miles and Huberman's (1994) reliability formula (Reliability = [Consensus / (Consensus + Disagreement)] x 100) was used to determine the agreement between the researchers' and co-observer's analyses, and the result was calculated as 88%.

One of the criteria of validity in qualitative research is reporting the data in detail and explaining how the researcher reached the results (Yıldırım & Şimşek, 2013). To ensure the validity of the study, it was reported in detail how the data collection tool was formed, how the data were collected and reported, and how the results were reached. In addition, students' answers for each theme and sub-themes are provided as examples.

In the first sub-question of the first question, the students were asked whether they designed a vehicle with their friends in the Science course and how effective their thoughts were in this design. In the other sub-question of the first question, the students were asked whether they prepared a project with their friends in the Science course and how the task sharing was done among them. The findings obtained regarding these questions are given in Table 8, together with their frequencies. In addition, sample answers for each sub-theme are given below.

Table 8

Students' Views on the Questions in the Main Theme of "Co-constructivism"

Main Theme: Collaborative design		
Sub-themes	Codes	*f*
Vehicle Design	Lack of application (S1, S2, S4, S7, S10, S11, S12)	7
	Individual study (S3, S5, S9)	3
	Influence of the student's ideas (S6, S8)	2
	Joint decision (S6, S8)	2
Project Preparation	Lack of application (S3, S5, S6, S7, S8, S10, S11)	7
	The project's being elective (S9, S12)	2
	Task sharing (S2, S4)	2
	Individual study (S1)	1

The students were asked questions about "vehicle design" and "project preparation", which are sub-themes, under the main theme of "co-constructivism". According to the "vehicle design" sub-theme, most students (*f*=10) stated that they did not design a vehicle with their friends. Three of them said that they designed a vehicle individually. The answers given by the students are as follows:

S11: *"I did not design a vehicle with my friends."* (lack of application)

S3: *"We made an electrical circuit. Everyone did it by him/herself."* (individual study)

S6: *"My thoughts were also influential while designing it, and also we made a joint decision."* (Influence of the student's ideas and joint decision)

According to the "project preparation" sub-theme, most students (*f*=9) stated that they did not prepare a project with their friends. Two of them stated that they did not prepare a project because they did not take a project assignment in the Science course. The answers given by the students are as follows:

S7: *"We did not prepare a project."* (lack of application)

S12: *"I did not take part in a project because it was elective."* (the project's being elective)

S4: *"Task sharing was made in the procurement of the materials. Also, one of us poured the mineral water, the other shredded the biscuit. Our teacher gave these tasks to us."* (task sharing)

In the first sub-question of the second question, the students were asked whether they took part in research with their friends in the Science course and contributed to them. In the other sub-question of the second question, the students were asked whether they prepared a presentation with their friends in the Science course and what they learned from their friends if they prepared a presentation. The findings obtained regarding these questions are given in Table 9 together with their frequencies:

Table 9

Students' views on the questions in the main theme of "collaborative work"

Main Theme: Collaborative work		
Sub-themes	Codes	*f*
Research and Contributions	Lack of application (S2, S3, S4, S5, S8, S9, S11)	7
	Different ideas (S6, S12)	2
	Success (S1)	1
	Permanence (S1)	1
	Correction of mistakes (S6)	1
	Resource support (S7)	1
	Participation (S10)	1
	Completing the deficiencies (S12)	1
Presentation Preparation	Lack of application (S1, S3, S5, S6, S7, S8, S9, S10, S11, S12)	10
	New knowledge (S2, S4)	2

Under the main theme of "collaborative work", the students were asked questions about the sub-themes of doing research and its contributions and preparing presentations. According to the sub-theme of research and contributions, more than half of the students (*f*=7) stated that they did not research with their friends. Students who researched with their friends stated that they learned different ideas the most (*f*=2). The answers given by the students are as follows:

S8: *"We did not research with friends."* (lack of application)

S6: *"I took part in a research. I learned different ideas and my friends corrected my mistakes."* (different ideas and correction of mistakes)

S1: *"We did a research about life and discoveries of a scientist. What I learned through working cooperatively became more permanent since I remembered them in the exam. And I passed the exam."* (success and permanence)

According to the sub-theme of preparing a presentation, most of the students (*f*=10) stated that they did not prepare a presentation with their friends in the Science course. The answers given by the students are as follows:

S12: *"I did not prepare any presentation with my friends."* (lack of application)

In the third question, the students were asked what effect their participation in class discussions in the Science course had on their learning. The findings related to this question are given in Table 10.

Table 10

Students' Views on the Questions in the Main Theme of "Social Experience and Interaction"

Main Theme: Social experience and interaction		
Sub-themes	Codes	*f*
Positive	New knowledge (S1, S3, S6, S9, S11)	5
	Better comprehension (S3, S5, S9)	3
	Fast learning (S1)	1
	A different point of view (S4)	1
	Correction of mistakes (S8)	1
Lack of application	No class discussions (S2, S12)	2
Neutral	No effect (S7, S10)	2

Under the main theme of "social experience and interaction", the students were asked about the effects of classroom discussions on learning. Most of the answers are positive (*f*=11). Two of the students stated that they did not discuss in the classroom, while the other two stated that the discussions did not affect learning. The answers given by the students are as follows:

S1: *"I learn different and new information from my friends."* (new knowledge)

S5: *"The more my friends give examples, the better I understand the subject."* (better comprehension)

S2: *"There is no discussion in the classroom."* (no class discussions)

S10: *"Some discussions are not effective."* (no effect)

In the fourth question, the students were asked which examples of our culture related to the subject they covered in the Science course. The findings were given in Table 11.

Table 11

Students' views on the questions in the main theme of "sharing culture"

Main Theme: Sharing culture		
Sub-themes	Codes	*f*
Existence of the application	Vegetables and fruits (S1)	1
	Elements (S2)	1
	Natural disasters (S11)	1
Lack of application	Lack of examples (S3, S4, S5, S6, S7, S8, S9, S10, S12)	9

Under the main theme of "sharing culture", the students were asked what examples they emphasized on the subject. Most of the students (*f*=9) stated that examples of our culture were not given. The answers given by the students are as follows:

S3: *"I do not remember whether we gave any examples."* (lack of examples)

S11: *"Examples of natural disasters in Afyon were given."* (natural disasters)

In the first sub-question of the fifth question, the students were asked about the effects of these real life examples on learning, and in the other sub-question, the effects of experiments on learning were asked. The findings are given in Table 12.

Table 12

Students' Views on the Questions in the Main Theme of "Relating with Real Life"

Main Theme: Relating with real life		
Sub-themes	Codes	*f*
The effects of examples from real life	Facilitating of comprehension (S1, S6, S7, S8, S11, S12)	6
	Transfer to real life (S4, S10)	2
	Correction of mistakes (S3)	1
	Positive effect (S2)	1
	Permanence (S5)	1
The effects of experiments on learning	Facilitating of learning (S3, S4, S8, S10, S11)	6
	Permanence (S2, S5, S7, S12)	4
	Positive Effect (S1, S9, S12)	2
	Responsibility (S9)	1
	Success (S10)	1

The biggest effect of real life examples was facilitating students' understanding of the subject (*f*=6). The answers given by the students are as follows:

S8: *"I learn the subject better with examples. When the teacher asks what the subject is, I think of examples first, not the subject. Considering the example, I also learn the explanation of the subject".* (facilitating of comprehension)

S10: *"We gave examples of the mixture of tea, water, and soil. I told my mother whether the ingredients in the meals are homogeneous or heterogeneous".* (transfer to real life)

The biggest effect of the experiments on learning was to facilitate learning (*f*=6) and ensure the subject's permanence (*f*=4), respectively. The answers given by the students are as follows:

S2: *"When we do experiments, what I learn becomes more permanent."* (permanence)

S10: *"Participating in the experiments of the subjects, covered on the days when I wasn't attending school, at other times helped me learn those subjects. I learned through the experiment and got a high grade from the exam."* (success)

Discussion and Conclusion

This study aimed to develop a scale to measure the co-constructionist environment in the Science courses. As a result of the exploratory factor analysis, the scale has become a five-dimensional scale. Accordingly, the first factor (collaborative design) consists of 6 items and explains 43.914% of the total variance. The second factor (collaborative work) consists of 6 items and explains 6.569% of the total variance. The third factor (social experience and interaction) consists of 6 items and explains 5.157% of the total variance. The fourth factor (sharing culture) consists of 5 items and explains 4.566% of the total variance. Finally, the fifth factor (relating to real life) consists of 4 items and explains 4.165% of the total variance. Thus, the scale consisting of 27 items and five factors explains 64.371% of the total variance. While the Cronbach Alpha coefficient of the scale is .950, the Alpha coefficients of the factors are as follows; .850, 852, .856, .874, and .868. Accordingly, the scale shows internal consistency with its factors. Item total, item remainder, and item discrimination indexes were examined for each item. In the item discrimination analysis, the difference between the item average scores of the lower 27% and upper 27% groups formed according to the total scores of the test was analyzed through an independent sample t-test, and the difference was found to be significant (p<.01). In line with these findings, the validity of the items on the scale is high. Confirmatory factor analysis was conducted to obtain the accuracy of the factors obtained from the exploratory factor analysis, and the confirmatory factor analysis results confirm the factor structure. Therefore, the developed scale can be used to measure the co-constructivist environment in the Science courses. The factor structure obtained from the exploratory factor analysis was confirmed by the confirmatory factor analysis results (RMSEA=.084; AGFI=.70; SRMR=.064; CFI=.91; NNFI=.90, χ^2/df=1.93). Moreover, items created after literature research were verified statistically.

The scale consists of five sub-factors: “collaborative design”, “collaborative work”, “social experience and interaction”, “sharing culture,” and “relating with real life”. The content of these sub-factors is in line with the concepts of co-constructivism as they are suggested as the main points of social constructivism in the study of Eastwell (2002). According to the “collaborative design” sub-factor items, students are expected to structure their knowledge and design new products together. The developing person is an active and constructive individual in a collective culture (Lyra & Valsiner, 1998, p. 187). While designing a new product or preparing a project with his/her friends, he/she establishes a dynamic relationship with others. Knowledge does not occur in the student alone but is formed by structuring with others (Reusser, 2001). Since the 6th and 7th Grade curriculum subjects such as force, motion and energy; conduction of electricity and electrical circuits; light and matter are suitable for designing a tool, co-constructivism serves well for this aim of Science courses.

The second sub-factor, named “collaborative work,” consists of the activities that students come together and do. Co-constructivism requires collaborative compromise. Two or more people are expected to come together and work collaboratively to build a common understanding (Reusser, 2001). In their scale development study, Johnson and McClure (2004) found five sub-factors to determine the constructivism environment. These are personal fitness, student compromise, joint control, critical voice, and uncertainty. Among them, the closest concept to co-

constructivism is student compromise. Cooperative learning lies at the heart of constructivism. Collaborative work is also one of the cornerstones of the theory of co-constructivism. In parallel with the study of Johnson and McClure (2004), "collaborative work" was found as one of the sub-factors forming the scale in this study. Conducting experiments in a school requires students to work in teams in a responsible and kind manner because students are able to share their ideas and discuss possible alternatives in a comfortable way. Co-constructivist environments make collaborative work possible in Science courses.

Items in the "social experience and interaction" sub-factor are generally composed of items that students come together and prepare a presentation. Students interact while preparing a presentation and collectively make a decision for each part of the presentation. Knowledge occurs between individuals who have common interactions and conventions. Social theory, called co-constructivism, covers peer interaction and higher-order thinking skills that vary according to the characteristics of social interaction (Reusser, 2001). Dialogue between students is a crucial variable of co-constructivism theory (Daws, 2005). Some studies in the field of Science (Marinopoulos & Stavridou, 2008; Pilatou & Stavridou, 2008) found that knowledge is structured in a social environment, and collaborative learning environments facilitate learning of Science courses. Strong engagement and active participation are significant features of co-constructivist theory. Through interaction with others, students will have different perspectives on issues related to science and technology as they share information with their peers. In this respect, this sub-factor of the Co-constructivism Scale in Science courses contributes to the objectives of Science teaching.

Items in the sub-factor named "sharing culture" include transferring culture to the classroom and exchanging culture with others. While structuring knowledge, the cultural field is structured together. Many learnings occur as a result of cultural sharing (Reusser, 2001). It is critical for science teachers to understand the fundamental, culturally-based worldviews that students bring to class and how culture supports these viewpoints. Science education is only successful if science can find a place in students' cognitive and cultural environments (Cobern, 1998). As the students have different cultural characteristics, they reflect different cultural aspects to the classroom, and teachers should benefit from these multicultural features of the students in a positive way. One of the ways to benefit from these cultural features is to blend culture sharing within the course activities. Applying the principles of co-constructivism facilitates culture sharing through social motivation, so the items in this sub-factor make it more concrete.

Items in the last sub-factor, "relating with real life" require giving examples from real life experience and conducting experiments. Through such activities, students relate their learning experiences to real life. Among the concepts that create co-constructivism, there is the relationship between learning experiences and real life (Reusser, 2001). For this reason, in a classroom in which a co-constructivist environment is provided, students should give real-life examples. Therefore, activities should be task-oriented, and the materials used and the types of assessment should be authentic. In Özgür's (2008) study, a scale was applied to students and teachers to determine the constructivist environment. One of the sub-factors is related to learning about life. It includes the item as "students can give interesting examples about science

and technology in daily life, thanks to what they learn in the course". This aspect of Özgür's (2008) study overlaps with one of the findings of this study. The items in this sub-factor were aimed to make students associate them with real life by giving examples from the subjects they learned about science. Science teaching aims to make students relate what they learn to everyday contexts, so teachers should relate science subjects to real life to make sense in students' minds. Moreover, in a classroom where the co-constructivist approach is adopted, students may easily find themselves in real-life situations.

Structured interview forms have eight questions under five main topics: the sub-factors of the previously developed scale (Ocak & Hocaoglu, 2018a). According to the qualitative questions related to the sub-factor as "collaborative design" of the scale, students have stated that they rarely design an instrument and prepare a project with their friends. According to the data about the sub-factor as "collaborative work", students have indicated that they rarely research and prepare presentations with their friends. According to the question related to the sub-factor called "social experience and interaction", students have mentioned that whole-class debates positively affect their learning. According to the question related to the sub-factor as "sharing culture", many students have stated that examples about culture were not given. According to the questions about "relating with real life", students mentioned that they gave examples about real life, and these examples and the experiments have facilitated learning and understanding most. It has been found that the qualitative results of this study have been mostly overlapped with the quantitative results of the study by Ocak and Hocaoğlu (2018b). Hereunder, it is possible to say that the validity and reliability of the scale called "Co-constructivism" at Science Lessons of secondary education, which was previously developed, has been ensured by the quantitative data, and the result is high.

The skills that Science courses want to develop in students (e.g., analytical thinking, entrepreneurship, communication, teamwork) are parallel with the main principles of co-constructivist learning. Therefore, if the teachers follow the principles of co-constructivism, science learning will be more meaningful and permanent for the students. This scale, "Co-constructivism" at Science Lessons of secondary education, is a beneficial tool for determining how well a school atmosphere adheres to a co-constructivist epistemology in terms of collaborative design, collaborative work, social experience and interaction, sharing culture, and relating Science subjects with real life.

Implications

The roles of teachers in a co-constructivist environment are to guide students and support them in engaging them in authentic and task-oriented, structured social interactions. The items in this scale are restricted to the objectives of the 6th and 7th Grade Science curriculum. Therefore, the objectives of Science curriculums at the secondary education level can be considered for further scale development studies. For further research, the environment of co-constructivism at Science courses can be examined in terms of the interaction and relationship between students and teachers.

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Statement of Responsibility

All of the authors contributed to the study equally.

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Preservice Teachers' Experience of History and Philosophy of Science Course: A Phenomenological Research

Öğretmen Adaylarının Bilim Tarihi ve Felsefesi Dersi Deneyimleri: Bir Fenomenoloji Araştırması

Sevim BEZEN* **Celal BAYRAK****

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ABSTRACT: This research aimed to lay bare pre-service teachers' experience of History and Philosophy of Science courses. Being a phenomenological design, this research has 19 pre-service teachers (age range 19-22 years; 10 male, 9 female) in its research group. Semi-structured interviews were used to collect data for the study. Seven open-ended questions prepared by the researchers regarding this research were directed at the pre-service teachers. This data was analysed by content analysis within the frame of descriptive phenomenology. At the end of this research, pre-service teacher experiences of History and Philosophy of Science were gathered under the following main themes: "In my opinion, the History and Philosophy of Science course…," "What kind of teaching I would do if it were me?" and "Have my Expectations Been Met?" It was determined that pre-service teachers support constructivist teaching, they use positive expressions concerning the course's educative and directive aspects, and they made some suggestions. One view that has come to the fore in the research was that a pre-service teacher should complete this course. It can be suggested that pre-service teachers should complete this course for their proficiency and personal growth.

Keywords: A history of science, phenomenological approach, philosophy of science, pre-service teachers, qualitative research.

ÖZ: Bu araştırmada, öğretmen adaylarının bilim tarihi ve felsefesi dersi deneyimlerinin ortaya çıkarılması amaçlanmıştır. Fenomenoloji deseninin benimsendiği araştırmanın çalışma grubunu 19 öğretmen adayı (yaş aralığı 19-22; 10 erkek, 9 kadın) oluşturmaktadır. Araştırmanın verileri, yarı-yapılandırılmış görüşme tekniği aracılığıyla toplanmıştır. Araştırmanın amacına yönelik araştırmacılar tarafından hazırlanmış olan yedi açık uçlu soru öğretmen adaylarına yöneltilmiştir. Araştırmada elde edilen veriler betimleyici fenomenoloji çerçevesinde içerik analiziyle çözümlenmiştir. Araştırma sonucunda öğretmen adaylarının bilim tarihi ve felsefesi deneyimleri "Bana Göre Bilim Tarihi ve Felsefesi Dersi…", "Ben Olsam Nasıl Bir Öğretim Gerçekleştirirdim?" ve "Beklentilerim Karşılandı mı?" ana temaları altında toplanmıştır. Adayların süreçte yapılandırmacı öğretimi destekledikleri, dersin öğretici ve yönlendirici yönüyle ilgili olumlu ifadeler kullandıkları ve çeşitli önerilerde bulundukları tespit edilmiştir. Araştırmada en çok öne çıkan görüş ise, eğitim fakültesinden mezun olacak her bir öğretmen adayı tarafından bilim tarihi ve felsefesi dersinin öğreniminin tamamlaması gerektiği olmuştur. Öğretmen adaylarının alan yetkinlikleri ve bireysel gelişimleri açısından ilgili dersin öğrenimini tamamlamaları gerektiği düşünülmektedir.

Anahtar kelimeler: Bilim tarihi, bilim felsefesi, fenomenoloji yaklaşımı, nitel araştırma, öğretmen adayları.

* *Corresponding Author*: Dr., Hacettepe University, Ankara, Turkey, sevimbezen@hacettepe.edu.tr, https://orcid.org/0000-0002-0304-5314
** Prof. Dr., Hacettepe University, Ankara, Turkey, cbayrak@hacettepe.edu.tr, https://orcid.org/0000-0002-9269-2029

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Science is defined as an activity that has been used by humankind to explain the universe. It is also regarded as a process that stems from human curiosity. In this process, humankind's place in the universe and its living conditions are explained. In short, science is a process in which knowledge is generated; and it is a significant aspect of our cultural and social life (Matthews, 1989). Human values, political and economic problems, and the aims of education can be discussed thanks to science (Harding, 2017). However, to do so, there is a need for people who can appreciate the place of science within the intellectual and social scheme and who have a highly developed understanding of science. The importance of teaching History and Philosophy of Science while raising a generation that has a critical approach to scientific knowledge and discussion has already been emphasised (Petersen et al., 2020). Indeed, related to several branches of science such as history and philosophy, History and Philosophy of Science is defined as the story of the birth and development of science (Kampourakis, 2019). In other words, the teaching process of History and Philosophy of Science involves science's contribution to society and scientists' efforts (Gandolfi, 2018). In this process, it was argued, students realise how science is indeed part of human development (Chapel, 2004).

History and Philosophy of Science have found their place in education programmes' priorities because concepts in education programmes can be taught in an integrated manner through History and Philosophy of Science (Irzik & Nola, 2014). For instance, learning History and Philosophy of Science is effective in developing problem-solving, decision-making skills, and scientific knowledge perception of pre-service teachers enrolled at faculties of education (Grüne-Yanoff, 2014). It is because science as a concept becomes concrete through the teaching of this course to make sense of scientific concepts (Matthews, 1989). Similarly, this course gives pre-service teachers the chance to interpret scientific knowledge's social and cultural effects. It also provides them with an environment where they can make sense of concepts, improve their individual ability to think, learn interdisciplinary knowledge, and make interdisciplinary connections by learning about scientists' lives and the historical period they lived (Williams & Rudge, 2016). In short, it is believed that solutions for problems in various areas of life can be found "with History and Philosophy of Science courses," and students or pre-service teachers can obtain several skills for social and cultural events (Matthews, 1989). Likewise, a teacher who has studied the History and Philosophy of Science can easily ensure conceptual change (Wandersee, 1986). In other words, teachers who have a command of historical developments can foresee possible difficulties to be faced (Çıbık, 2016; Lin et al., 2010). When taught about the historical context, students learn concepts by making sense of them, and a course enriched by History and Philosophy of Science improves their attitude towards the topic (Lin et al., 2010). In short, the literature shows how knowing the History and Philosophy of Science can enrich learning environments and increase students' reasoning and critical thinking (Clough, 2011). At this point, it is important to note that pre-service teachers' views of and attitudes towards History and Philosophy of Science courses are significant (Teixeira et al., 2012). Determining what their views and attitudes are would contribute to the field since these pre-service teachers are the ones who would transfer their knowledge of History and Philosophy of Science to the next generation (Kokkotas et al., 2009). Consequently, with all these expressions, the effect of the History and

Philosophy of Science courses was thus emphasised; most importantly, it is evident that this course should be integrated into the education programs (Gandolfi, 2020). In this respect, it is known that with the update in teacher training undergraduate programs in Turkey in 2018, History and Philosophy of Science courses are included in general knowledge elective courses. This course enabled pre-service teachers to have an opinion of disciplines different from their own such as mathematics, philosophy, literature, politics, and geography. Moreover, such a course is also aimed at making students appreciate the interconnectedness and the united nature of human success stories (Hodson, 2019; Matthews, 1989). For instance, in a study carried out by Güney and Bakanay (2018), it was determined that pre-service teachers' interests in their fields increased when they had the opportunity to establish a connection between the things they learned in History and Philosophy of Science courses and their fields. The study noted that pre-service teachers thought that communication was better, and the whole course ran much smoother when it was enriched by History and the Philosophy of Science. Moreover, pre-service teachers expressed that they lack the necessary knowledge of how to relate History and Philosophy of Science with their fields because they did not have a separate History and Philosophy of Science course. In this respect, it was revealed that teaching programs need a course that focuses solely on the History and Philosophy of Science and that this course should be compulsory for every pre-service teacher. Similarly, Yenikalaycı and Yüksel (2020) also consulted pre-service teachers' opinions on the History and Philosophy of Science. Their study asked pre-service teachers open-ended questions on Ancient Greece, Medieval Europe and Scholastic Thought, Islamic cultural geography, Mesopotamia, Renassaince Europe, and the Age of Enlightenment. At the end of the study, it was found out that pre-service teachers have incomplete or incorrect information even about the History and Philosophy of Science related to their fields because there was little room for the History and Philosophy of Science in teaching programs. In the study, it was voiced out that pre-service teachers need the teaching of a separate History and Philosophy of Science course to get rid of their incorrect or incomplete knowledge. In conclusion, based on the studies carried out in Turkey in recent years, it can be argued that History and Philosophy of Science courses are a necessity; they would provide a significant advantage for pre-service teachers in their professional lives, and therefore, the views of pre-service teachers who have this experience would give a new impulse to the field.

Aim

This research aims to lay bare pre-service teachers' experience of History and Philosophy of Science courses. To this end, the History and Philosophy of Science course, which has been offered as an elective for the first time, was selected; and the views of pre-service teachers from different disciplines were examined with a phenomenological outlook. The study sought an answer to the question: "How do pre-service teachers make sense of their experience of the History and Philosophy of Science course?"

Method

Research Design

This research was designed in the phenomenology design because it focused on how pre-service teachers make sense of their personal experience and the nature of making sense of things (Christensen et al., 2015; Patton, 2014). Phenomenology design provides rich ideas about how pre-service teachers make sense of their experience (Smith & Osborn, 2015). Moustakas (1994) also argues that the contexts and situations affecting the phenomena can be determined, and expertise can easily be put forth (Creswell, 2013). In this respect, this study aimed to determine how pre-service teachers make sense of and experience the History and Philosophy of Science course and determine their views of this course. Therefore, it was decided that descriptive phenomenology would explain this situation because it aimed to describe pre-service teachers' perceptions, ideas, and experiences while revealing their knowledge. Individuals' experiences could be approached using descriptive phenomenology (Weinberg et al., 2018).

In the study, the experiences of the pre-service teacher were evaluated through descriptive phenomenology irrespective of the subjective convictions of the researchers. The meaning of their experiences and how their experiences were interpreted by themselves were investigated without reducing them to a biological entity (Vagle, 2018, p. 28). This study aimed to make visible the invisible aspects of pre-service teachers' experiences; it did not aim to put forward or confirm any theory while doing this. The investigation process progressed by employing an unbiased and critical perspective. As such, lived experiences could be described (Dahlberg et al., 2008). In short, the study used the descriptive phenomenology research design planned by Giorgi (2009, p. 166) by turning Edmund Husserl's transcendental phenomenology into a research method.

Study Group

The researchers applied at the Ethics Committee of a Turkish state university where the research was planned to be realised. After receiving a positive response from the said committee, the researchers contacted the pre-service teachers enrolled in the History and Philosophy of Science course at this university's education faculty. Study group of this research was determined by the voluntary participation of pre-service teachers who enrolled in the History and Philosophy of Science course during the Fall semester of the 2020-2021 academic year. The 19 pre-service teachers (age range 19-22; 10 Male, 9 Female) were sophomores at the education faculty. Five of these pre-service teachers' study Guidance and Psychological Counselling, four of them study Science Education, three of them study Computer and Instructional Technology Education, two of the study Primary School Mathematics Education, two of them study Biology Education, one of them study Chemistry Education, one of them study Physics Education and one of them study Mathematics Education. There are various views on the number of people in a study group in phenomenology research in literature. Based on Dukes and Polkinghorne, Creswell (2014) argues that the number of participants can vary between 3 and 25 while Dukes (1984) suggests 3-10 people and Polkinghorne (1989) offers 5-25 people as participants. In this respect, this study considered the literature and the voluntary participation of 19 pre-service teachers. These pre-service

teachers elected the History and Philosophy of Science course and experienced the History and Philosophy of Science in their natural learning processes.

History and Philosophy of Science Course

In this study, the teaching was carried out by being faithful to the History and Philosophy of Science course, which is part of the teacher training undergraduate program and aims to teach concepts holistically with the History and Philosophy of Science. Therefore, during the course period, science was mentioned in the old age, the middle age, the new era, the modern era, the Hellenistic era, the renaissance, Islam, the novel, and ancient Greece. The History and Philosophy of Science course were taught each subject for a semester according to the following four steps (Şeker et al., 2013):

Interest step: In this step, pre-service teachers were attracted to the course with biographical stories about scientists. For instance, Blaise Pascal (1623-1662) was made into account as follows: "Pascal's genius manifested when he was rather young. When he was 12, he started drawing circles and equilateral triangles. Although he did not know the geometry, he discovered that the sum of the triangle's interior angles equals two right angles. As a child, he asked his father, "What does geometry study?" His father replied, "It studies drawing shapes correctly and examines the relationship between parts of those shapes." Based on this answer, Pascal secretly formulated geometry theories and started to prove them. Finally, his father noticed his son's talent, and he gave him Euclid's elements and Apollonius' conics.

Socio-cultural Step: In the socio-cultural step, the aim was to correlate science and society's history and philosophy. Social repercussions of the scientists' work were examined in terms of science, culture, and technology. For instance, of course, the printing machine invented by Johannes Gutenberg in 1436 was relatively primitive at the beginning. However, it was still highly significant as a tool in initiating mass printing. Then, this invention was discussed in the course in terms of science, society, and technology.

Epistemological Step: At this step, methods scientists use in generating scientific knowledge were introduced to pre-service teachers, and the objective was for students to understand the changeability of science. During this introduction, the lecturer was present in the classroom as a guide. At this point, for instance, a video about Galileo Galilei (1564-1642) was shown to students (Link: https://www.youtube.com/watch?v=LPG8XNFLRsk). Science tells that a previously moving object would stop if it is left on its device; its movement can be maintained only by a push or pull from an external force. The video shows that Galileo subscribes to a contrary view and contends that "A moving object would maintain its movement at a monotonous speed when it is freed from external factors." Galileo tried to prove this to his audience, especially to the professors whose courses he was enrolled in, by throwing lead pieces of different weight from the Pisa Tower. In this respect, the process in which Galileo exhibited the changeability of science and discovered two significant laws of physics was presented to the students via this video.

Conceptual Step: In this final step, by creating discussion opportunities, students were enabled to realise the similarities between the conceptual structures they formed during the learning process of this course and the concepts they have developed in their minds before concerning the History and Philosophy of Science. At the same time, pre-

service teachers supported structuring their field knowledge and discussing ideas through group studies.

Data Collection and Application

Data of this research were collected by semi-structured interview technique. In qualitative studies, interviews are called "purposeful chats," and here, the aim was to reveal the pre-service teacher experience (Merriam, 2009). First, seven open-ended questions prepared by the researchers regarding this research were directed at the pre-service teachers. The questions were finalized in line with expert opinions. To reach rich discourse, interactive interviews were carried out with the pre-service teachers; a thorough examination of pre-service teachers' experiences was aimed by asking flexible in the questions and providing additional questions (Burns & Peacock, 2019). Interviews were realised one-on-one following the last week of the semester, with three weeks on the place, days, and hours determined by the pre-service teachers themselves; they took about 50-55 minutes. In this process, each pre-service teacher was met twice. All interviews were audio-recorded with the permission of pre-service teachers. Data were analysed after these audio recordings were transmitted to digital media.

In the interviews, the following questions were asked:

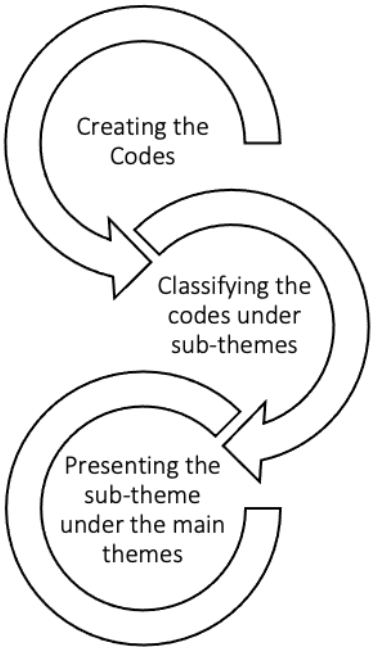
- Could you please explain what the History and Philosophy of Science courses mean for you?
- How would you, as a pre-service teacher, define the place of History and Philosophy of Science courses in education? Explain in detail.
- In your opinion, what is the appropriate way to teach the History and Philosophy of Science course? Explain in detail.
- Keeping in mind your educational journey, what teaching level do you think is appropriate for the History and Philosophy of Science course? Explain in detail.
- Has taken the History and Philosophy of Science course made you notice that you have erroneous thoughts that you thought were true? Explain in detail.
- Have your expectations concerning the History and Philosophy of Science courses been met in the process? Explain.
- What quality can a lecturer teaching History and Philosophy of Science have for teaching to be effective? Explain.

Data Analysis

Qualitative data obtained in this research were analysed by content analysis within the framework of descriptive phenomenology. Analysis steps utilised in the study can be found in Figure 1.

Figure 1

Data Analysis Steps



As shown in Figure 1, interviews conducted with the pre-service teachers were transcribed; these transcriptions were read and re-read. Then, expressions of a similar nature were brought together to create codes. For instance, "*I think the past should be recreated in the course environment by sample case texts. I think simulations and demonstration experiments can be employed to do so (PT#5)",* along with similar expressions by pre-service teachers showed that case studies, demonstration experiments, video shows, experiments, simulations, questions and answers, discussions, and group studies techniques should be utilised in the teaching of the History and Philosophy of Science courses. When these views gathered similar expressions, codes such as case studies, demonstration experiments, video shows, experiments, simulations, questions and answers, discussions, and group studies were formed. Then, these codes were classified under sub-themes in a meaningful way, taking into account the characteristics of these codes. Because the codes given in the sample support constructivist teaching, it was decided that the codes should be gathered under the 'Constructivist Teaching' sub-theme. Finally, sub-themes were presented under the main themes to indicate what each section meant to be easily understandable by the reader. To this end, the constructivist teaching sub-theme was presented under the main theme titled "What Kind of a Teaching Would I do If It Were Me?" Formed as such by the researchers, the codes, sub-themes, and main themes were constantly revised during the process. The codes, sub-themes, and the main themes determined by the researchers were presented to experts who are specialised in content analysis for qualitative studies; two experts who hold PhDs in the field were asked to code the data. Thus, looking at the harmony and consistency between the researchers and the field experts, final themes, sub-themes and codes were decided; and a consensus about the schematic demonstration given in the findings section was also reached. As a result of data analysis, content analysis, three themes and several subthemes under these themes were reached. To support the research findings, pre-service teachers' views were

presented in the relevant section directly in the form of quotations. In the presence of direct quotes, personal information about the participants was not used for ethical reasons; instead, each pre-service teacher was given a code (PT1, PT2, …., PT19) (Creswell, 2013; Yin, 2014).

Validity and Reliability Studies

In the study, believability, transferability, consistency, and confirmability dimensions were handled within the context of validity and reliability. In this respect, a literature survey was carried out to ensure believability, and a conceptual framework was formed. Detailed information about the participants and all stages of the study were presented, expert opinion was consulted, thereby helping readers decide on the believability of the expressions. Pre-service teachers were informed about the aim of the study; confidentiality was emphasised so that pre-service teachers would feel safer and more comfortable during the interviews. Moreover, reliable data were obtained by having a prolonged interaction with the pre-service teachers. To ensure the transferability of the study, interviews and the analysis steps were explained in detail. Likewise, the study group, data collection tool, the process, and the data analysis were defined to make sense for the reader. Data obtained in the study were presented objectively by providing direct quotations; the relationship between the processes was also explained.

Moreover, the study was raised easily to comprehend by supporting it with figures and using accessible language (Creswell, 2014). For consistency, the data of the research and the conclusion should be consistent. To this end, interviews were recorded while they were being carried out face to face. Then the data set were coded first by multiple researchers and then by experts; accord between them was checked. When codings differed, a consensus was reached going over it together. In other words, inconsistencies in codes, sub-themes, and the main theme so that there is unity in data. Finally, within the scope of confirmability, data of the study, free of personal assumptions and biases, were confirmed by the conclusions reached by the survey. Relevant associations were drawn with the literature, and the findings were presented to the reader. Moreover, data analysed by the researchers were stored digitally to access whenever necessary (Creswell & Poth, 2018).

The Researchers' Role

In this research, the aim was to describe pre-service teachers' experience, and it was conducted by researchers with the knowledge of qualitative research in a curious process. In this process, researchers were open-minded, flexible, accommodating, patient, and emphatic; they were also determined, insistent, and curious. They conducted this research with the objectivity expected from a researcher doing descriptive phenomenology. Researchers, both proficient in their field and good listeners, were consistent and treated the pre-service teachers warmly and candidly. They listened to their expressions carefully, always keeping their values in mind. Moreover, they provided an environment in which pre-service teachers could answer questions honestly and comfortably. In conclusion, the researchers displayed a sensible and sensitive attitude in managing the process (Smith & Osborn, 2015).

Ethical Procedures

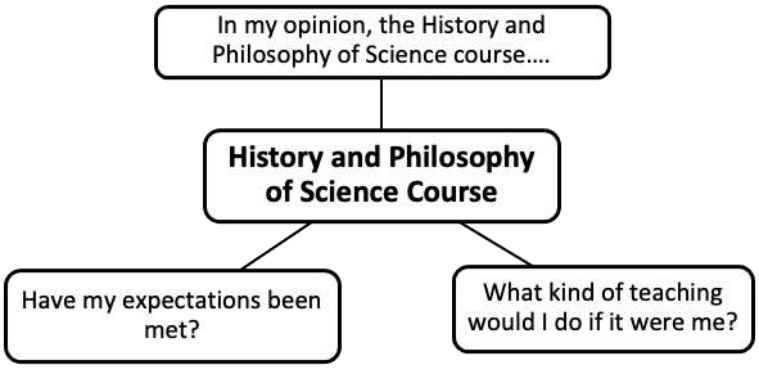
Pre-service teachers were briefed about the ethical issues and the voluntary nature of participation before the interviews started. They were informed that they could conclude the interview any time they liked. They do not have to answer any question; they do not want to answer so that their identity or any information related to their identity will never be revealed. The data obtained from the interviews will be kept confidential. This research was found ethically appropriate with the decision numbered 35853172-600 at the meeting held by Hacettepe University's Ethics Commission on 10 November 2020.

Findings

Findings obtained from the interviews were determined by the teaching process of the History and Philosophy of Science courses they have experienced. Pre-service teachers' perception of the study was gathered under three main themes. These themes are "In My Opinion, The History and Philosophy of Science Course…," "What Kind of a Teaching Would I Do If It Were Me?" and "Have My Expectations Been Met?" (Figure 2).

Figure 2

Preservice Teachers' Experience of History and Philosophy of Science Courses



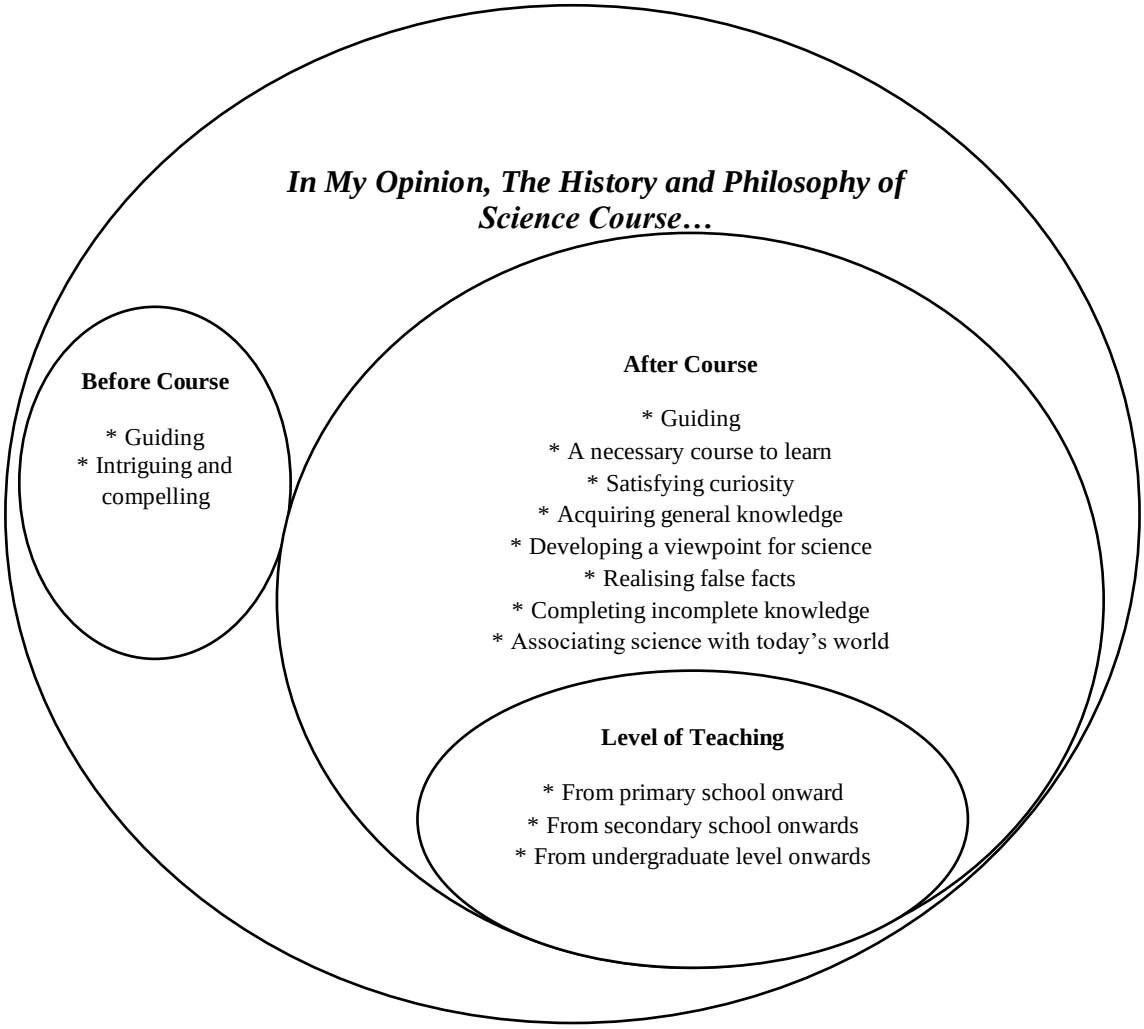
The themes determined in the research put forth how pre-service teachers make sense of the History and Philosophy of the Science courses, how they think the study should be taught, and what their expectations are. The content of these themes is given in detail below.

In My Opinion, The History and Philosophy of Science Course…: Before and After the Course

In this theme, pre-service teachers underlined what the History and Philosophy of the Science courses mean for them. "In My Opinion, The History and Philosophy of Science Course…" central theme was handled under two dimensions in this research. These were "before course" and "after course." Codes for these subthemes were also determined. Sub-themes and regulations concerning the central theme "In my opinion, the History and Philosophy of Science course…" can be found in detail in Figure 3.

Figure 3

Subthemes and Codes Concerning the Central Theme "In My Opinion, The History and Philosophy of Science Course…"



Before course, pre-service teachers indicated that the History and Philosophy of Science course would guide and were curious about the course. Examples of pre-service teachers' views on them before course subtheme can be found below: (PT: Preservice Teacher, #: Number):

> "History and Philosophy of Science courses remind me how and in what conditions science has progressed. I took this elective course, thinking that it would guide me because I have wanted to know more about the relationship between History and the Philosophy of Science and today's world (PT#4)."
>
> "… I have always wanted to learn about the History and Philosophy of Science, experience, inventions, and make sense of all of these. I have always been intrigued by how scientists developed their ideas or how events were grounded in science's philosophy (PT#19)."

Pre-service teachers' views revealed that they are willing to learn in this course and curious about its content. They maintained that they acquired some general knowledge thanks to this course and could relate scientific advancements in today's world.

After course, pre-service teachers still contended that this course was instructive; they also mentioned that their curiosity was satisfied. They maintained that this course contributed to their general knowledge and improved their perception of science. They

also indicated that they could complete their incomplete knowledge and realised they had specific false facts. It was determined that pre-service teachers had different views on when this course should be taught: their opinions varied from primary school to an undergraduate degree. Their ideas are presented below:

> "A teacher should have general knowledge, answer students' questions, and be proficient in their field; so, I can say that a pre-service teacher should take this course. I do believe this course satisfies one's sense of curiosity (PT#14)."
>
> "Everything in life stems from philosophy. In this course's teaching, we should first determine our philosophy of education and then after forming models, teach about scientists by mixing our teaching with history. For instance, we cannot teach a student about the theory of evolution before we teach them about science history. The student will not understand it if they cannot differentiate between a thesis and a hypothesis. In other words, this course should be taught based on science. This course may raise a generation who can relate scientific history to today and generate new ideas (PT#1)."
>
> "Thanks to this course, one can learn how scientists think and how science is done. This course can change our science view by showing us how some of our knowledge is based on false facts. I realised how much incomplete understanding I had in this course. I thought many of the inventions occurred in the West but learned that some of them indeed happened in the East (PT#8)."
>
> "This is an essential course taught to students progressively from the primary school social studies course. This course applies to all fields of life. In the primary school level, information may be limited to the first age so that topics become more attractive, and students are intrigued. More in-depth teaching can be done at the secondary school and undergraduate levels (PT#16)."
>
> "Students who have already decided on their field at the secondary school level can be briefed about this course's content, and they can be taught how they can obtain scientific knowledge in their areas. It can be ensured that students deepen their understanding without any mistrust of science and jointly analyse the birth philosophy and history of science (PT#11)."
>
> "Mentally mature students can focus on this course more efficiently and more willingly; that is why I think this course should be taught at the undergraduate level. This would enable more in-depth learning of topics and lecturers will more efficiently conduct the study with students who can quickly answer questions (PT#7)."

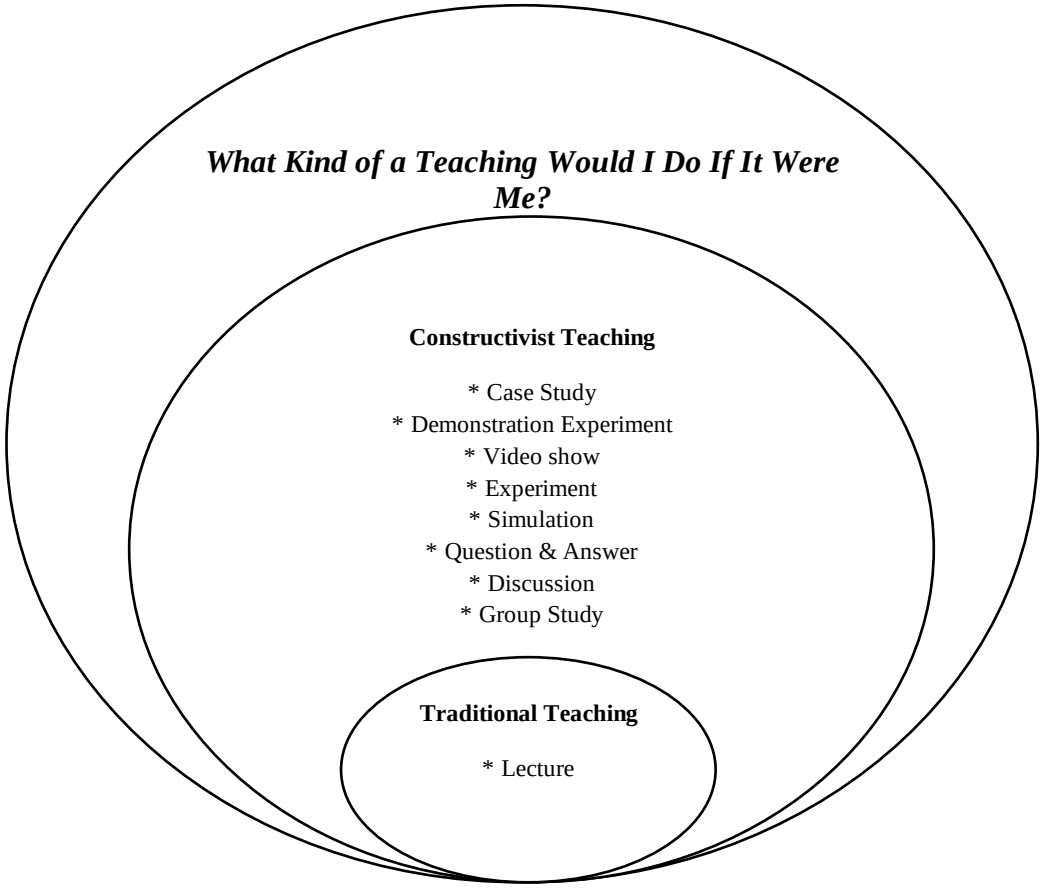
Pre-service teachers' expressions reveal that this course is essential; pre-service teachers think that each pre-service teacher should have sufficient knowledge of History and Philosophy of Science.

What Kind of a Teaching Would I Do If It Were Me?: Constructivist Teaching

Pre-service teachers regarded the teaching of History and Philosophy of Science courses in a single dimension. They argued that the teaching of this course should be done according to constructivist theory. Subthemes and codes concerning the central theme "What Kind of a Teaching Would I Do If It Were Me?" were given in detail in Figure 4.

Figure 4

Subthemes and Codes Concerning the Central Theme "What Kind of a Teaching Would I Do If It Were Me?"



Pre-service teachers emphasised that the teaching of History and Philosophy of Science should be done according to constructivist theory; they specified that such learning should be realised by using case studies, demonstration experiments, video shows, experiments, simulations, question and answers, discussions and group studies. Pre-service teachers also indicated that traditional teaching methods could also be utilised in certain parts of the course. Pre-service teachers' views are as follows:

> "In this course, students should be included in the process, and there should be frequent group studies. In my opinion, the level should not rely only on lecturing, but it can, of course, be done at specific points. Moreover, videos about scientists' inventions can be shown or experienced environment through experiments (PT#12)."
>
> "I think the past should be recreated in the course environment by sample case texts. I think simulations and demonstration experiments can be employed to do so (PT#5)."
>
> "Pre-service teachers enrolled in this elective course can be given a plan appropriate for their discipline. Scientists appealing to pre-service teachers can be examined and what they changed and what their viewpoint was can be focused on. Instead of a detailed lecture on these scientists' inventions, their contribution to science should be the focal point. Interesting questions can be used as an introduction, and then the course should continue with questions and answers. Examples from daily life can help create a discussion environment. As such, everything can be handled with a critical perspective (PT#17)."

Pre-service teachers' expressions indicate that they take constructivist theory to teach for the History and Philosophy of Science courses; they also support learning by doing and experiencing.

Have My Expectations Been Met?: Positive Expressions, Suggestions, and Characteristics of the Lecturer

It was determined that pre-service teachers explained their History and Philosophy of the Science course and their expectations of this course in a positive expression. Pre-service teachers also listed the necessary qualities required of the lecturer of this course. Pre-service teachers' names were presented under the central theme "Have My Expectations Been Met?" Subthemes were determined as "Positive Expressions", "Suggestions", and "Characteristics of the Lecturer." Subthemes and codes determined in the research were explained in detail in Figure 5.

The views of pre-service teachers presented under the "Positive Expressions" subtheme reveal that this course met their expectations because pre-service teachers underlined the educative aspect of this course; they also mentioned that learning occurred by doing and experiencing rather than by rote and that the use of different teaching methods and techniques ensured permanent education. Moreover, they said they learned while at the same time having fun. Pre-service teachers' views are as follows:

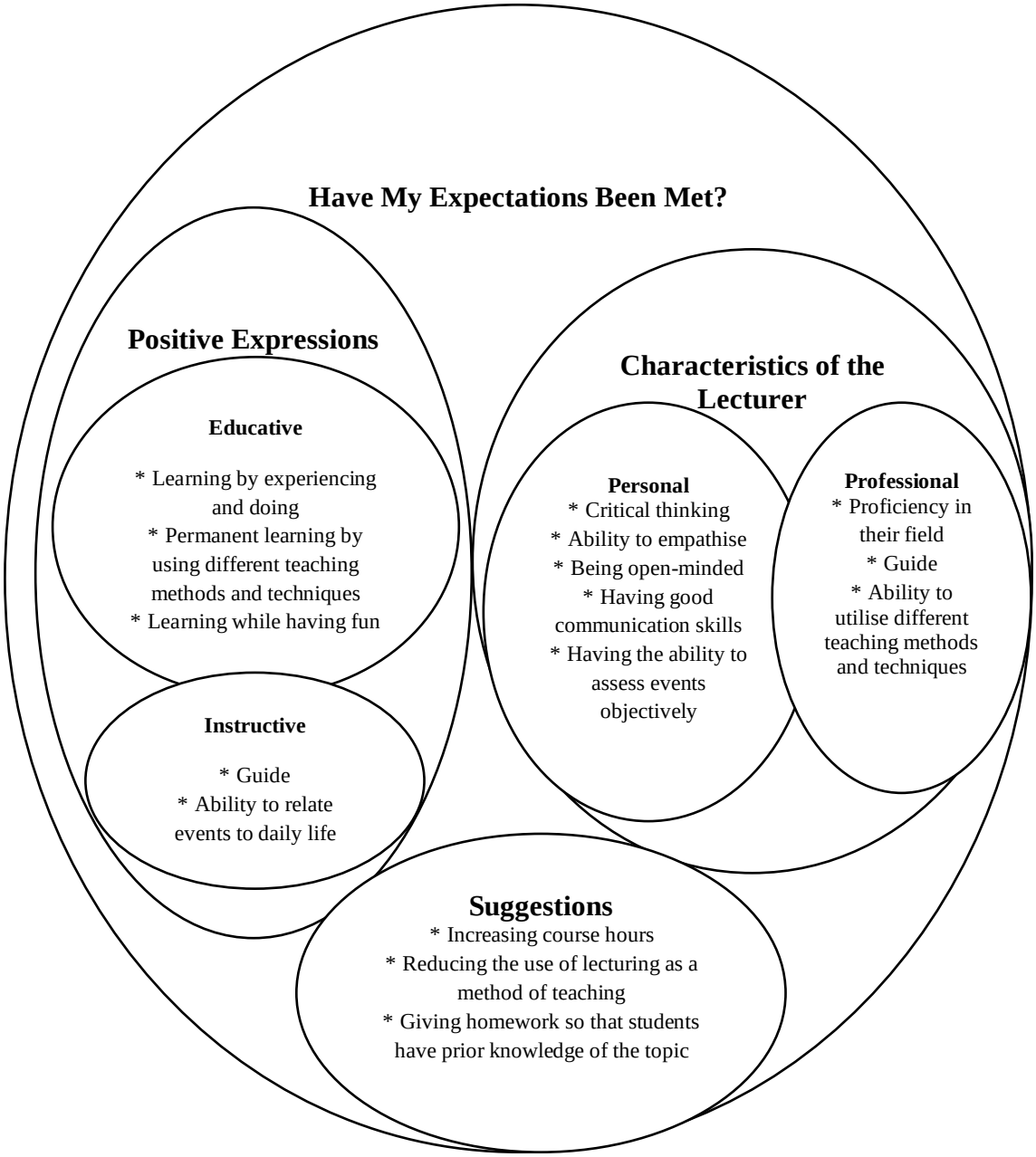
> "I was never bored in this course, and I think exciting points were adequately emphasised. I willingly came into the classroom and learned while having fun. Using different teaching methods and techniques made the subject even more comprehensible (PT#18)."
>
> "This is not a course in which you learn things by rote. Thus, I believe things should be known by doing, experiencing, and activities. I can say that this course was fun and useful for me because of its teaching process (PT#5)."

In the guiding dimension, pre-service teachers indicated that the lecturer adopted the role of a guide. Moreover, they underlined that the lecturer's guiding role created a healthy discussion environment, taking advantage of having pre-service teachers from different disciplines. Various activities enabled many of the pre-service teachers to have information outside of their field. About the instructive dimension, pre-service teachers also mentioned that they could relate things to daily life. Their views are as follows:

> "Under the lecturer's guidance, I had the opportunity to have in-course discussions with friends from other disciplines. I learned from my friends about things I have had no idea about before. I can say that a course consisting of students from different disciplines is an advantage (PT#7)."
>
> "I have always wanted to learn about the History and Philosophy of Science from A to Z, and I did thanks to this course. I noticed examples from daily life in particular; under our lecturer's guidance, I can now relate what I know of everyday life (PT#10)."

Figure 5

Subthemes and Codes Concerning the Central Theme "Have My Expectations Been Met?"



Under the "Suggestions" subtheme, pre-service teachers' suggestions for this course were presented. Pre-service teachers said that the course content was loaded, and the duration was short; they underlined that the course hours should be increased because two hours a week was not enough. As they mentioned before, they thought lecturing should be done only minimally in this course; they maintained that having prior knowledge of topics before coming to class would affect their learning. In other words, they believed that coming to the course prepared would help them make sense of the issues and enable them to be more active in the process. Some examples of pre-service teachers' views are as follows:

> "I think the course content is loaded and the duration limited; we had to rush through the topics, and thus we did not have enough time to internalise some concepts: they remained at the surface level and were not fully learned (PT#1)."

> "I think we should be given a type of homework before the course to come to the class prepared. I think this would help us make sense of the topics more efficiently, and we can participate in the process more actively. For example, we can watch an extract from a movie or read a book about the subject or study as a group before the course (PT#15)."

Pre-service teachers had constructive views, and they believed the course hours of this elective course should be increased.

Finally, pre-service teachers thought that the lecturer's characteristics were as useful to the teaching process as their professional qualities. In the professional dimension, pre-service teachers indicated that the lecturer should be proficient in their field, instructive, and should have the ability to use different teaching methods and techniques. The personal characteristics dimension said the lecturer should have critical thinking skills and empathise, be open-minded, communicative, and objective. Pre-service teachers' views are as follows:

> "The first thing is, the lecturer should be proficient in the field; only then can permanent learning be ensured. I also believe that the lecturer should utilise different teaching methods and techniques to be fun and educative. Hence, students became active participants in the study (PT#3)."

> "I think personal qualities are as important as professional proficiency to teach this course. I mean, a person who can think critically and can empathise, who is open-minded and objective, can conduct this course more effectively (PT#13)."

Pre-service teachers' views revealed that the lecturer's field did not make any difference; having specific professional and personal characteristics was considered more important.

Discussion, Conclusion, and Suggestions

This research aimed to lay by pre-service teachers' experience of History and Philosophy of Science courses. At the end of the study, pre-service teachers' knowledge was collected under several themes, namely, "In My Opinion, The History and Philosophy of Science Course…," "What Kind of a Teaching Would I Do If It Were Me?" and "Have My Expectations Been Met?" In the theme titled "In My Opinion, The History and Philosophy of Science Course …," pre-service teachers expressed their opinions before and after the course. In the article titled "What Kind of a Teaching Would I Do If It Were Me?" It was seen that pre-service teachers supported constructivist teaching. Finally, in the theme titled "Have My Expectations Been Met?" It was seen that pre-service teachers used positive expressions for the educative and instructive aspect of the course. They talked about the lecturer's characteristics, before course the History and Philosophy of Science course, the pre-service teachers listed among their reasons for electing this course. They thought this course was instructive and interested in taking this course. Since this was an elective course on general knowledge, it was evident that pre-service teachers willingly and curiously elected it. Indeed, it could be evinced that pre-service teachers wanted to understand the scientific process (Suprapto et al., 2019). After teaching, pre-service teachers' views were still complimentary, and they indicated that this course was instructive and that it was able to satisfy their curiosity. Niaz (2016) also mentioned that it resulted from the fact that pre-service teachers now knew the emergence of scientific knowledge and scientists' characteristics. It was thought that pre-service teachers objectively handled science, and having an increased interest in scientific studies might have been useful here (Fusti & Gilbert, 2000).

Additionally, pre-service teachers underlined how they acquired general knowledge and how their perception of science improved. This finding was compatible with the literature; raising pre-service teachers' awareness for this course was regarded as the cause of such development (Dougherty & Moore, 2019). Similarly, after this course, pre-service teachers completed their incomplete knowledge and realised the false facts that assumed to be true. As was also discussed in the literature, pre-service teachers associated the History and Philosophy of Science with the West (Song & Kim, 1999). Considering the level of education, the pre-service teachers' lack of prior knowledge of science in Islam, which is indeed part of their own culture, should be inquired. Pre-service teachers must know the importance of their own culture within the world culture and the history of civilisation; they are expected to have an increased interest in the History and Philosophy of Science, being inspired by scientists' contributions (Gandolfi, 2018).

It was revealed in this research that pre-service teachers' level of knowledge increased with the History and Philosophy of Science courses; pre-service teachers expressed how they had a cognitive change once they realised their mental contradictions. Çıbık's study (2016) supported this finding, which argued that pre-service teachers could associate science with daily life. In other words, pre-service teachers could now make connections between science and society, and they could find solutions to problems by using technological advancements (Gandolfi, 2020). The most frequently underlined expression in this research was that a pre-service teacher should take this course. Although this was an elective course, pre-service teachers could recommend taking it for personal development and professional proficiency. Indeed, after taking this course, pre-service teachers would be able to poke their own students' curiosity, enrich their in-course presentations, have lectures by creating contextual relations between concepts, and support their students in seeing the totality of a content (Fouad et al., 2015; Nouri et al., 2019). Pre-service teachers supported the use of constructivist teaching in the teaching of this course. It is believed that using constructivist teaching in this course would have an enormous effect on the cognitive development of pre-service teachers (Bächtold & Munier, 2019). Pre-service teachers themselves argued how utilising constructivist teaching would result in permanent learning; they maintained that different teaching methods and techniques should be employed to run the process. Other research also arrived at the same conclusion (Farris et al., 2019); research in the literature shows that pre-service teachers do not want to be taught in a monolithic manner; instead, they support learning that is realised by inquiry, encouraging creative ideas and through in-course interaction (Laçin-Şimşek, 2019). In this respect, pre-service teachers indicated that the lecturer should use different techniques such as case studies, demonstration experiments, simulations, group studies, question and answer sessions, and discussions. Besides pre-service teachers' expressions, there is evidence in the literature that constructivist teaching methods and techniques are useful in making sense of scientific knowledge (Norris et al., 2005). In the literature, it was also argued that constructivist teaching might increase the interest in the History and Philosophy of Science courses; a sense of curiosity may be poked by asking questions related to the subject, motivation can be improved, and students can become more active in the problem-solving process (Klassen, 2009).

In addition to these, pre-service teachers indicated that traditional teaching methods such as lecturing could be used in some parts of teaching along with constructivist teaching. However, pre-service teachers repeatedly emphasised how rote learning has no place in this course and showed that they do not support traditional instruction. Indeed, since this course requires conceptual and procedural knowledge, it can only be secured by innovative applications (Bächtold & Munier, 2019). Pre-service teachers also argued that the History and Philosophy of Science courses could be taught at various levels, beginning with primary school. It was indicated that the teaching of History and Philosophy of Science could be used beginning with social studies courses in primary schools; it could be done at the secondary school level in explaining how scientific knowledge is obtained and about the birth of science, and it could be used at the undergraduate level in in-depth learning. Several studies in the literature also contend that this course, which is believed to be appropriate for different teaching levels, should be provided for students in education programmes (Kim & Irving, 2010). In other words, the objective is to teach students how they can search for knowledge and have a theoretical basis. Another goal is ensuring that students learn the process of scientific research and the emergence of scientific knowledge. Moreover, arriving at conclusions about learning and reporting it and raising awareness about scientific research methods are among the desired outcomes (İngeç et al., 2016; Rudge & Howe, 2009).

Another result obtained from this research is that pre-service teachers learned by doing and experiencing things by having fun. The use of different teaching methods and techniques ensured permanent learning. Pre-service teachers mentioned the lecturer's instructive role; they maintained that they could now relate daily life things. Some conclusions were drawn in the literature about teaching History and Philosophy of Science based on constructivist theory (Bächtold & Munier, 2019; Garik et al., 2015; Hadzigeorgiou, 2006). Moreover, the research underlined that the lecturer created a lively discussion environment using the fact that there were students from different disciplines in the course, which ensured that the pre-service teachers could know outside of their areas via various activities. It shows that the lecturer's instructive role created an opportunity for pre-service teachers' academic success to increase; the lecturer helped for meaningful and permanent learning by giving students confidence and motivation (Nouri et al., 2019). It was determined in this research that pre-service teachers regarded the characteristics of a lecturer in two aspects. They indicated that the lecturer's unique features are as important as their professional proficiency. Professionally, the lecturer was expected to be proficient in their field, instructive, and use different teaching methods and techniques. Personally, the lecturer was expected to have skills in critical thinking, empathising, open-mindedness, communication, and being objective. Pre-service teachers' expressions revealed that this course's lecturer should have multiple qualities (Cross, 1916). Sarton (1930) also focused on the point and argued that the most critical factor in teaching History and Philosophy of Science is the lecturer because he believed that an inappropriately provided education would have devastating results. In this respect, this course should be taught by individuals capable of thoroughly explaining things.

Finally, pre-service teachers argued that the content of this course was packed while the duration was limited. It can be suggested at this point that the number of

course hours should be increased instead of omitting certain parts of the content (Emren et al., 2019). Another result of the research was that pre-service teachers believed that prior knowledge would be useful in their learning before coming to the course. Pre-service teachers' level of experience concerning History and Philosophy of Science is insufficient. Indeed, most of their prior knowledge comes from media or popular books (Ma & Wan, 2017; Metz et al., 2007). That is why pre-service teachers expressed that they could be given homework in the form of group work or based on an extract from a book or a movie before the course; it was determined that this was how they wanted to improve their prior knowledge levels. In other words, pre-service teachers believed that coming to the class prepared would ensure more permanent learning and more active course participation. These pre-service teachers' suggestions aim to increase education quality (Ma & Wan, 2017).

Limitations

Consequently, this research laid bare the pre-service teacher experience of History and Philosophy of Science courses. Participants of this research consisted of pre-service teachers who took the History and Philosophy of Science course for the first time in a state university. In this sense, the study reflects the views and experience of a limited group. Moreover, this research has a known limitation due to its research design, which does not allow its conclusions to be generalised. The difficulty of getting rich data, data analysis, determining a research group, and the researcher's experience also create limitations. To obtain rich data from pre-service teachers, interviews were held immediately following the course's teaching to minimise memory issues. The research aimed to keep in mind when determining the research group; pre-service teachers were selected only if they had experienced the History and Philosophy of Science course. In the data analysis, the whole data was examined about the formed themes, without losing sight of a holistic viewpoint. Finally, it can be argued that researchers have knowledge and experience in planning and running qualitative research (Creswell & Creswell, 2018). The research problem could be rehandled with more participants and through qualitative and mixed research approaches in prospective studies to overcome these limitations. The research problem can be discussed within the frame of different variables using various assessment tools and methods. Moreover, a comparative analysis of pre-service teachers' views and experiences and teachers who have taken this course would shed light on the field differently.

Implications

This study laid bare that teaching the History and Philosophy of Science is necessary for pre-service teachers' field proficiencies and personal growth. However, it also became evident that the teaching process of this course should be improved. In this regard, it is thought that in the faculties of education that teach the History and Philosophy of Science, it is necessary to develop teaching materials for the course, to simplify the rich content to be included in the curriculum in a planned manner, and to take into account the difficulty of appreciating the conditions of a time that may be so significantly different from today. For this, a dynamic interaction should be ensured between the lecturer, the curriculum, and the teaching materials to be used. The instructors are expected to carry out practical teaching, being aware of the difference

between the planned and the implemented course process, and using curriculum materials and additional/guide materials. It is thought that exciting and interactive activities that would support in-class interaction should be specially included in the teaching materials (Ma & Wan, 2017; Nouri et al., 2019). Moreover, it is believed that the inclusion of this course in the teacher training programs in Turkey since 2018 will increase the number of sources to be designed in this field, and these sources should be adapted to the teaching process.

Statement of Responsibility

Sevim Bezen; methodology, validation, formal analysis, investigation, resources, data curation, writing-original draft, writing – review & editing, visualization, supervision, project administration. Celal Bayrak; methodology, validation, writing-original draft, writing – review & editing, visualization, supervision, project administration.

Conflicts of Interest

The authors declare that they have no conflict of interest**.**

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The Relationships among Teacher Leadership, Teacher Self-Efficacy and Teacher Performance

Öğretmen Liderliği, Öğretmen Öz Yeterliliği ve Öğretmen Performansı Arasındaki İlişkiler

Yener AKMAN*

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ABSTRACT: This study examined the relationships among teacher leadership, teacher self-efficacy and teacher performance according to teachers' views. The participants of the study were 401 teachers working in the state (K12) schools in Altındağ, Ankara, who were determined through a random sampling method. The data were collected through Teacher Leadership Scale, Self-Efficacy Scale, and Job Performance Scale. A relational survey model was adopted in the study. The data were analyzed through quantitative analysis techniques, including descriptive statistics, correlation analysis and multiple linear regression analysis. The findings indicated high levels of perceptions of teacher leadership, self-efficacy, and performance in teachers. Moderate, positive, and significant relationships were observed among teacher leadership, teacher self-efficacy and teacher performance. In addition, teacher leadership was shown to predict self-efficacy and performance significantly. The findings pointed out that teacher leadership behaviors were an important concept involved in teacher self-efficacy and performance.

Keywords: Teacher leadership, teacher self-efficacy, teacher performance, school.

ÖZ: Bu araştırmada öğretmen liderliği, öğretmen öz yeterliliği ve öğretmen performansı arasındaki ilişkiler öğretmen görüşlerine göre incelenmiştir. Araştırmaya Ankara ili Altındağ ilçesinde kamu K12 okullarında görev yapan 401 öğretmen katılmıştır. Araştırma verileri Öğretmen Liderliği Ölçeği, Öz yeterlilik Ölçeği ve İş Performansı Ölçeği ile toplanmıştır. Araştırmada ilişkisel tarama modeli benimsenmiştir. Veri kümesi üzerinde nicel analiz teknikleri uygulanmıştır. Araştırma verileri betimsel istatistikler, korelasyon analizi ve çoklu doğrusal regresyon analizi ile çözümlenmiştir. Bulgulara göre öğretmenlerin öğretmen liderliği, öz yeterlilik ve performans algıları yüksek düzeydedir. Öğretmen liderliği, öğretmen öz yeterliği ve öğretmen performansı arasında orta düzeyde, pozitif ve anlamlı ilişkiler gözlemlenmiştir. Ayrıca öğretmen liderliğinin öz yeterlilik ve performansı anlamlı şekilde yordadığı tespit edilmiştir. Bulgular öğretmen liderliği davranışlarının öğretmen öz yeterlilik ve öğretmen performansı üzerinde rol oynayan önemli bir kavram olduğuna işaret etmiştir.

Anahtar kelimeler: Öğretmen liderliği, öğretmen öz yeterliliği, öğretmen performansı, okul.

* *Corresponding Author*: Asst. Prof. Dr., Süleyman Demirel University, Isparta, Turkey, yenerakman@sdu.edu.tr, https://orcid.org/0000-0002-6107-3911

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In the 20th century, school leadership research mostly focused on the behaviors of school administrators that gained power from their legal positions. Today, however, teacher leadership has been the subject of many studies as an important concept (Blackman, 2010; Carver, 2010; Hunzicker, 2012; Jacobson, 2011; Katzenmeyer & Moller, 2009; Leonard et al., 2012). Specified as a reflection of democratic participation in school, distributed leadership is particularly considered to influence the decision-making process. In fact, some researchers stated that distributed leadership was the basis of teacher leadership (Frost, 2008; Gronn, 2000, p. 324; Pounder, 2006). Teachers should be given the opportunity to leave the classroom setting and cooperate with their environment to realize and develop their leadership capacities (Dozier, 2007). Similarly, teacher leadership is an opportunity for teachers to be a part of the decision-making process (Donaldson & Johnson, 2007). These necessitate a versatile view on administration and the need for the participation of different voices in the administration of today's schools rather than traditional leadership approaches. The participation of stakeholders in administrative processes is considered to contribute to school efficiency. It is also stated that teacher leaders have the willingness, knowledge, and skills to initiate the process of change in schools (DiRanna & Loucks-Horsley, 2001; Hunzicker, 2012).

It is well-established that administrators and colleagues significantly affect teachers' leadership behaviors. The positive climate in schools might encourage teacher leader candidates to participate in administrative processes. In this process, the support, guidance, and trust provided especially by school administrators can increase teachers' willingness to take responsibility. School administrators play an important role in the development of teacher leadership (Buckner & McDowelle, 2000). For instance, Diamond and Spillane (2016) stated that teacher leadership largely depends on the leadership approaches of administrators. Teacher leader candidates are appreciated for their innovative practices, support for their colleagues, sensitivity to school problems and efforts to be a part of the solution. Thus, teachers' courage and multifaceted responsibility skills might improve. This is considered to increase the self-efficacy and self-confidence of teacher leader candidates and encourage their performance behaviors in time. As a psychological construct, self-efficacy is believed to be affected particularly by school administrators' approach to leadership, teachers' level of participation in decisions, and interpersonal cooperation (Guo et al., 2011; Shachar & Shmuelevitz, 1997; Skaalvik & Skaalvik, 2007).

Additionally, the positive interaction between school administrators and teachers was observed to facilitate the emergence of leadership behaviors of teachers by increasing teacher motivation (Lieberman & Friedrich, 2010). Similarly, teacher motivation plays an important role in leadership skills (Reeves & Lowenhaupt, 2016). These indicate the importance of motivation on teachers' self-efficacy beliefs and leadership behaviors. Performance is another construct positively related to motivation. Research has shown that employees with higher motivation also have higher performances (Akman, 2018; Woessmann, 2011). Self-efficacy, in particular, can be regarded as one of the antecedents of teacher leadership. Teacher leaders affect and direct their environment in many ways and enable new practices to become widespread throughout the school. It is also acknowledged that teachers who are monitored and

have an impact on their environment have high educational performances (Hunzicker, 2012).

In this study, the development of teacher leadership is considered to contribute to the educational processes in schools. Also, teacher leadership points to a partially informal process facilitating a more friendly work environment with other teachers. In this environment, it can be asserted that leader teachers who guide and train their colleagues with expert knowledge might support their development. Therefore, this might direct teacher development in schools to an alternative other than just individual efforts or formal in-service training processes cooperated between colleagues. It is established that teachers who feel their instructional qualifications enhance during the informal education process have strengthened self-confidence and self-efficacy. Additionally, teachers who have mastered their fields in terms of expertise and pedagogy are predicted to improve in terms of effectiveness and performance and considered to raise the students' academic success. In the literature, it has been observed that high teacher self-efficacy increases teacher performance and student academic success (Olsen, 2008; Wahlstrom & Louis, 2008). In addition, the adoption of the teacher leadership approach in schools suggests that the workload of school administrators might reduce. For example, school administrators can solve problems informally through teacher leaders instead of directly intervening in some problems among teachers. This can therefore be time-saving for school administrators.

Moreover, teacher leadership is an approach that affects not only teachers but also all employees developmentally. It turns stagnation into a dynamic process. As a result, it is an approach that encourages the cooperation and competence of all employees. Teachers can be regarded as role models for students. For this reason, the approach should become widespread so that it affects both employees and students. Recent years have witnessed a growing interest in teacher leadership reflecting the democratic participation in school administration in Turkey. Determining the perceptions about teachers' potential leadership development is therefore deemed significant.

Teacher Leadership

Despite different conceptualizations, teacher leadership is an approach based on developing other teachers' educational practices by influencing them (Katzenmeyer & Moller, 2009). Different perspectives have enabled teacher leadership to be examined extensively and considered as an umbrella term. In the literature, teacher leaders are expressed with various titles such as coach, coordinator, and headteacher (Neumerski, 2012). In this process, the teacher leadership initiative tried to determine the basic competences for teacher leadership. Over time, different standards have been developed for teacher leadership. In addition, various certificate and diploma programs have become widespread. It has even been considered a criterion in teacher evaluations in some states in the USA (Colorado Department of Education, 2015; Danielson, 2014).

Moreover, some events on teacher leadership were organized. For instance, "The National Teacher Leadership Initiative" was launched by the National Education Association, wherein the competences of teacher leaders were discussed. Furthermore, the Center for American Progress held an event titled "Teacher Leadership" (Wenner & Campbell, 2017). Crippen and Willows (2019) defined teacher leaders as individuals

who inspire, encourage, and empower their colleagues. It was emphasized that distributed and collaborative leadership approaches were at the core of teacher leadership (Frost, 2008; Gronn, 2000, p. 324; Pounder, 2006). Teacher leadership is therefore expressed as a more dynamic and spontaneous phenomenon rather than static by structure. In other words, it can be asserted that the construct develops in an informal context. This can also facilitate the emergence of potential leaders among teachers. Also, teacher leadership develops continuously and has an informal leadership role (Frost, 2008; Pounder, 2006). York-Barr and Duke (2004) specified that teacher leadership is a different form of leadership that focuses on cooperation rather than authority. Similarly, teacher leadership is associated with the democratization of schools, teacher learning and the culture of cooperation in schools (Muijs & Harris, 2003). It can further be emphasized that teacher leaders exhibit transformational leadership qualities and direct other teachers to various activities that might ensure the development of schools (Pounder, 2006).

It is acknowledged that teacher leaders affect other teachers by sharing innovative learning experiences, providing community service, mentoring, participating in workshops, contributing to the solution of in-school or environmental problems, and connecting with universities (Crippen & Willows, 2019; Petrie, 1995; Reeves & Lowenhaupt, 2016). These practices can be considered teachers' getting out of the classroom and expanding their area of influence. According to Danielson (2006), the capacity of teachers to influence, direct and motivate their colleagues and other employees lie at the center of teacher leadership. Therefore, teacher leadership was expressed as an instrument enhancing teacher professionalism and student achievement indirectly (Crowther et al., 2009; Leithwood et al., 2010). As the official leaders of their schools, school administrators play a critical role in the development of teacher leaders. School administrators with an approach and a visionary perspective deprioritizing the hierarchical status relations might try to achieve the school's objectives in a collective understanding with teachers (Andrews & Lewis, 2007). Besides, Lieberman and Friedrich (2010) declared that teachers might have higher motivation and exhibit active leadership behavior when they express their views freely and administrators endorse their views. In addition, teachers' self-confidence increases when school principals share their experiences with teachers, showing that they trust, support, and encourage teachers (Buckner & McDowelle, 2000).

Katzenmeyer and Moller (2009) suggested that teacher leaders exhibit leadership behavior in four different areas: (i) school management, (ii) student activities, (iii) official tasks, and (iv) teacher leadership. Some researchers examined the construct in a three-dimensional structure in cooperation with organization, profession, and colleagues (Beycioğlu & Aslan, 2010; York-Barr & Duke, 2004). Teacher leadership consists of four dimensions: (i) the source of legitimacy of leadership, (ii) support to do the job, (ii) the purpose of the teacher influence, and (iv) the method of influence (Berg & Zoellick, 2018). Addressing teacher leadership with different perspectives in the literature makes it difficult to define and determine which dimensions it comprises. This demonstrated the need for leader behavior in practice and changes in the process of being a leader. Some researchers have accordingly discussed teacher leadership in the context of the individual's practical behavior and identity acquisition process. The practical process concentrates on teacher activities, such as creating a culture of success, enhancing the

learning environment, and encountering barriers to the school structure (Crowther et al., 2009; York-Barr & Duke, 2004). On the other hand, identity acquisition indicates the experiences in the leadership process, such as personal experiences, development of trust, social roles, and interactions (Gonzales & Lambert, 2001). The approach in this study mostly focuses on the practical behaviors of teachers within the context of teacher leadership dimensions.

Teacher leadership was extensively discussed in previous studies. Prevalent discussion points were the effects of teachers' classroom practices, experiences, motivations, professional development programs, teacher quality, or burnout on leadership skills (Cheng & Szeto, 2016; Reeves & Lowenhaupt, 2016; Snoek & Volman, 2014). It can be asserted that the studies examining teacher leadership in Turkey have also increased. In these studies, data collection tools were developed to measure the perception of the construct (Beycioğlu & Aslan, 2010). The studies also sought to determine the opinions of teachers about the construct (Beycioğlu & Aslan, 2012; Kılınç & Recepoğlu, 2013) and its relationship with different types of organizational behaviors such as motivational language (Demir, 2014), leader-member exchange (Öztürk & Şahin, 2017), classroom management tendencies (Öntaş & Okut, 2017) and school effectiveness (Cansoy & Parlar, 2018).

Teacher Self-Efficacy

Teachers are one of the most critical elements behind student achievement. Despite the significance of teachers' professional and cultural competences and expertise to cultivate qualified students, their psychological status might also influence educational efficiency. Self-efficacy can be defined as a construct involved in the psychology of teachers in the school environment. Studies have shown that self-efficacy is a contemporary construct despite being examined for the last few decades (Bandura, 1977, 1997; Cheung, 2008; Hipp & Bredeson, 1995; Kaçar & Beycioğlu, 2017; Skaalvik & Skaalvik, 2007; Tschannen-Moran & Johnson, 2011). The basis of the self-efficacy construct comes from the Social Cognitive Theory put forward by Bandura (1977). Self-efficacy is defined as an individual's belief in their abilities in the process of successfully performing an action (Bandura, 1977). Tschannen-Moran et al. (1998) asserted that self-efficacy is the belief in teachers' ability to organize and perform the assigned practices to complete a teaching task in school. In other words, the self-efficacy perceptions of teachers might imply teachers' relationship with various factors such as teaching strategy, methods and techniques, approach to environmental organization, classroom management skills and interaction with students.

Research pointed out that teacher self-efficacy is related to individual differences and school characteristics (Hoy & Woolfolk, 1993). Factors such as school climate, leadership styles of school administrators, the decision-making structure of schools, teachers' professional experiences, and teacher collaboration were related to teacher self-efficacy (Guo et al., 2011; Hipp & Bredeson, 1995). Studies in the literature found that professional experience positively affects self-efficacy (Cheung, 2008; Wolters & Daugherty, 2007). In addition, it was observed that the strong interaction between the internal stakeholders of schools and the influence of teachers on various decisions enhanced the self-efficacy of teachers (Moore & Esselman, 1992; Shachar & Shmuelevitz, 1997). Since schools are socially dominant institutions,

interpersonal relations can affect their functioning. In this sense, a sincere working environment is considered to provide a supportive school climate, wherein teachers might increase their multifaceted competences with a mutual understanding. Similarly, it was reported that school administrators who supported teachers contributed to their self-efficacy by establishing trust- and respect-based relationships (Skaalvik & Skaalvik, 2007).

Bandura (1997) asserted that vicarious experience, verbal persuasion, psychological arousal, and mastery experience affected teachers' self-efficacy beliefs. Vicarious experience is the observation of positive or negative experiences by following the lesson taught by an expert teacher. Verbal persuasion is the verbal interactions about teacher's performance or success. Psychological arousal is the sense of efficacy, either of anxiety or excitement, gained as a result of an activity. Mastery experience is the experiences gained in the process of a course taught by the teacher (Tschannen-Moran et al., 1998). Previous research showed that the perceptions of teacher candidates about their talents are influenced by the quality of supervision (verbal persuasion) and experiences of teaching skill (mastery experience) (Yeung & Watkins, 2000). It was also emphasized that the verbal persuasion attempts (inter-individual relationship) of administrators and colleagues contributed significantly to the self-efficacy beliefs of young teachers (Tschannen-Moran & Johnson, 2011). In fact, research showed that in the beginning years of teaching, self-efficacy beliefs changed frequently, and positive interpersonal interactions enhanced the self-efficacy of young teachers (Bandura, 1997). In line with these findings, positive interactions with administrators and colleagues in the school environment might be claimed to enable teachers to express themselves more comfortably. Teachers can thus become a guide in their environment by discovering and revealing their hidden powers. Considering the relationship between interpersonal relations, teacher leadership and self-efficacy at school, addressing the related constructs together is deemed important.

Teacher Performance

The existence of organizations depends on their ability to achieve their goals through effective and efficient practices. Quality education can be achieved through the interaction and harmony of numerous elements, including teacher performance. Performance is expressed as the behavior of an employee to achieve a specific goal (Campbell et al., 1990). According to Özdemir (2014), teacher performance is the behaviors that teachers exhibit by integrating their knowledge, skills, and motivation to achieve organizational goals. Performance is an organizational behavior influenced by various factors that can be individual (e.g., experience, knowledge, skill, age, etc.) or environmental (e.g., administrative approach, organizational climate, colleagues, characteristics of job, etc.). High performance is rooted in the harmonious relationship between the mentioned factors (Weightman, 2004, p. 160-161). In the literature, Cerit (2012) stated that performance is related to leader-member interaction, while Pitts (2009) pointed out that qualified internal communication increases performance. Also, some researchers have emphasized that performance is positively affected in organizations with clear goals, duties, authorities, and responsibilities (Babin & Boles, 1996). In addition, Akman (2018) stated that the motivation and performance of teachers increase in schools with high organizational justice.

Moreover, significant relationships between job satisfaction and performance were found in a meta-analysis study including 312 studies (Judge et al., 2001). Furthermore, Dilbaz-Sayın and Arslan (2018) noted that professional development, organization of the learning environment, interaction in the classroom, contribution to the development of students, interaction with the environment and being a role model are the factors to be observed in evaluating teacher performance. When the factors affecting performance are considered holistically, it is safe to say that performance is affected by personal and environmental factors, whether in schools or different sectors. The approach of self-efficacy and teacher leadership in the present study can also be considered in the context of both individual and environmental factors.

Studies indicated that teacher performance was associated with school administrators' leadership approaches and leadership adjustment (Abu Nasra & Arar, 2019; Cerit, 2012; Cheng, 2013; Korkmaz, 2005; Özdemir & Gören, 2017; Tuytens & Devos, 2012). While examining the construct, most researchers based performance on transformational leadership theory (Bass, 1985), leader-member exchange theory (Graen, 1976) and social change theory (Blau, 1964). These theories propose that performance might improve in a leader-employee relationship with a just social sharing. According to two factor theory, the performance of employees is affected by meeting their psychological needs such as autonomy, empowerment, and personal development (Herzberg et al., 1959). In the process of teacher empowerment, teachers' perceptions of self-efficacy and their levels of participation in decisions play an important role (Bogler & Nir, 2012). These explanations show that the presence of teachers in an environment enabling them to take the initiative while performing their duties positively affects various behavioral outcomes. It also points out the importance of the school administrators creating a supportive environment.

The Relationship among Teacher Leadership, Teacher Self-Efficacy and Teacher Performance

Teacher leaders can be regarded as informal leaders in schools. It can be maintained that leader teachers affect other teachers just as school administrators affect teachers. It is acknowledged that increasing the instructional competence of their colleagues is among the missions of teacher leaders. Teachers who are instructionally well-endowed are considered to have increased self-confidence. Various studies on this subject have shown that teacher self-efficacy is associated with teaching quality (Guo et al., 2012; Klassen & Tze, 2014). For instance, Allinder (1994) stated that teachers with a strong sense of self-efficacy are more open to new ideas and more willing to apply new methods to meet students' needs. In addition, Day et al. (2016) noted that the instructional leadership or transformational leadership displayed by school administrators alone is insufficient to explain teacher self-efficacy. Furthermore, it was emphasized that teacher leadership might raise teacher self-efficacy by improving other teachers, school and instructional management.

Various studies regarded teacher self-efficacy as a variable that positively affects teachers' performance (Caprara et al., 2006; Skaalvik & Skaalvik, 2010; Tims et al., 2012). To exemplify, Saks (1995) pointed out that self-efficacy is the primary determinant of performance. The reason for the increase in performance may be the willingness of teachers who feel competent in any subject to exert sufficient effort

concerning their duties. Additionally, teachers with strong self-efficacy were claimed to work harder, especially in difficult times (Tschannen-Moran & Hoy, 2001). Therefore, it can be seen that the high self-efficacy of teachers also increases their performance (Elliott et al., 2010; Olsen, 2008; Schunk & Ertmer, 1999). The mentioned arguments indicate direct relationships among the variables.

Most studies have shown that quality leadership positively impacts employee performance (Abu Nasra & Heilbrunn, 2015; Chen & Kanfer, 2006). Transformational leadership significantly affects performance in studies on leadership and performance (Fernet et al., 2015; Vigoda-Gadot, 2007). Considering that teacher leaders exhibit transformational leadership qualities (Pounder, 2006), significant relationships between performance and teacher leadership might be predicted. Namely, both types of leadership indicate active practices and emotional interactions (Bass, 1985). It can be argued that the innovative educational approaches expected from teacher leaders, proactive behaviors towards the solution of problems, and sincere cooperation between individuals support these views. This also indicates that teacher leaders take more responsibility in in-school practices. In this sense, it was emphasized that teachers who have quality interactions with school administrators voluntarily perform higher responsibilities (Moss et al., 2009). Also, school administrators' approach to leadership and cooperative behaviors with teachers was positively associated with teacher self-efficacy (Guo et al., 2011).

Purpose

This study aimed to reveal the relationships among teacher leadership, teacher self-efficacy, and teacher performance. In this regard, the following research questions were addressed:

1. What is the level of teachers' perceptions of teacher leadership, self-efficacy and performance?
2. Are there statistically significant relationships among teacher leadership, self-efficacy, and performance?
3. Is organizational development (OD) a significant predictor of self-efficacy and performance?
4. Is professional development (PD) a significant predictor of self-efficacy and performance?
5. Is collaboration with colleagues (CwC) a significant predictor of self-efficacy and performance?

Method

This study focused on the relationships among teacher leadership, teacher self-efficacy, and teacher performance. Data were analyzed by quantitative methods in this study, adopting a relational survey model.

Sample

The study was carried out in state (K12) schools in Altındağ, Ankara. According to the data from Ankara Provincial Directorate of National Education [APDNE], 4689 teachers work in these institutions (APDNE, 2020). The research was conducted with the sample selected from the population formed by teachers. While determining the

number of teachers to be included in the sample, a table of sample size was used. Reaching at least 333-357 teachers with 5% tolerance was deemed sufficient for the representation of the population (Cohen et al., 2007, p. 104). The participants were determined by convenient sampling. In this regard, considering the possibility of data loss, 500 teachers were aimed to reach, but the feedback was received from 401 teachers. 199 of the participants in the sample were women (49.6%) and 202 were men (50.4%). In addition, 108 of them work in primary school (26.9%), 186 in secondary school (46.4%) and 107 in high school (26.7%).

Data Collection Tools

In this study, teachers' perceptions of teacher leadership were determined through "Teacher Leadership Scale" developed by Beycioğlu and Aslan (2010). Perceptions of self-efficacy were ascertained through "Teacher Self-efficacy Scale" adapted to Turkish by Karaoğlu (2019). Perceptions of performance were identified through "Job Performance Scale" adapted by Çöl (2008).

Teacher Leadership Scale (TLS)

Teachers' perceptions of teacher leadership were measured by TLS, made up of 25 items and a three-factor structure (OD, PD and CwC). The scale was developed in a five-point Likert style. With the exploratory factor analysis (EFA), all dimensions of the scale whose structure validity was tested explained 57.23% of the total variance. In addition, the Cronbach's Alpha coefficient indicated the reliability of the scale (OD: .87; PD: .87; CwC: .92). Some of the sample items in the scale were as follows: "Willingness to collect information and prepare reports about the school" and "Giving confidence to students". Analyses were repeated on the current dataset. As a result of the CFA, the t values of items 5, 4, and 6 were found to be insignificant. These items were therefore excluded from the dataset. Moreover, a correlation was established between items 24-25 in line with the modification indices. Goodness of fit values achieved as a result of the final CFA indicated the validity of the scale at an acceptable level [$\chi 2$=754.04; *df*=169; $\chi 2/df$=4.46; AGFI=.80; RMSEA=.08; CFI=.93; NFI=.90]. Cronbach's alpha reliability coefficients were calculated .65 for OD, .84 for PD, .70 for CWC with an overall value of .92. Given the analyses, the TLS was proved to be a valid and reliable data collection instrument.

Teacher Self-Efficacy Scale (TSES)

TSES consists of 12 items under three dimensions (i.e., student engagement, teaching strategies and classroom management). As a result of the CFA analysis of the original scale, the goodness of fit values was calculated as: $\chi 2$=326.69; *df*=50; $\chi 2/df$=6.53; GFI=.95; RMSEA=.07; CFI=.97; NFI=.97. Cronbach's alpha coefficients of the scale showed that the scale was a reliable data collection instrument (student engagement: .73, teaching strategies: .75, classroom management: .74, and overall: .88). The scale has such items as: "How much can you try to control behavior that disrupts the order of the class?" and "How much effort can you make to ensure that your students comply with classroom rules?" Validity and reliability analyses of the scale were repeated. Since the t value of item 1 was not significant (t: 1.74) according to the CFA, it was removed from the dataset, and the analysis was repeated. Modification

suggestions were applied in order not to reduce the content validity in the second CFA. As a result of the second CFA, a correlation was established between error items 11-12 and error items 6-5, considering the modification indices. Following this analysis, the goodness of fit indices was: $\chi 2$=167.88; *df*=42; $\chi 2/df$=3.99; AGFI=.89; RMSEA=.08; CFI=.94; NFI=.92. In the analysis, $\chi 2/df$ value was found above the specified range. More than one fit indices were found as a result of the CFA. In this process, all indices were evaluated together instead of a single indice while determining the fit (Jöreskog & Sörbom, 1993). Reliability analysis indicated the reliability of the scale (student engagement: .70, teaching strategies: .69, classroom management: .82 and overall: .84). Validity and reliability analyses showed that TSES was a valid scale.

Job Performance Scale (JPS)

The scale consists of four items. The Cronbach alpha reliability coefficient of the JPS was calculated as .82. Validity and reliability analyses were also repeated on the existing dataset. Since the t value of item 1 was insignificant (t: .46) as a result of the CFA, the analysis was repeated by removing it from the dataset. Perfect goodness of fit indices were achieved after the second CFA ($\chi 2$=.0; *df*=0; AGFI=1.0; RMSEA=.00; CFI=1.0; NFI=1.0). In addition, the reliability coefficient of the scale was found to be .70. As a result, it was established that the JPS is a data collection instrument that can be used in the current study.

The Procedures and Data Analysis

The data were collected in June-July, 2020 by reaching teachers through a form prepared on Google forms. In the study, the perception level of the variables was analyzed through descriptive statistics (arithmetic mean, standard deviation, etc.). The level of the relationships among the variables was performed by correlation analysis. Predictive relations were revealed through regression analysis. The data were first transferred to the SPSS analysis program. It was then investigated whether the dataset met the assumptions for multivariate analysis. These assumptions can be expressed as normal distribution of data, multicollinearity, and lack of autocorrelation among the variables. For normality assumption, kurtosis and skewness values were examined. Values between -1.35 and 1.17 for teacher leadership, -1.43 and 1.38 for self-efficacy, and -.89 and -.02 for performance were calculated. Values between ±1.5 indicate univariate normality. Homoscedasticity was examined for the assumption of multivariate normality. The presence of homoscedasticity indicates the assumption of normality. In this context, the scatter plot showing the spread as the same width towards the middle indicates the homoscedasticity (Tabachnick & Fidell, 2013). Multicollinearity was tested through VIF and tolerance values. In the study, VIF and tolerance values were calculated between 2.49 and .40 for OD, 2.89 and .34 for PD and 2.56 and .39 for CwC. In the literature, the VIF value less than 10 and the tolerance value higher than .2 are interpreted as no multicollinearity (Çokluk et al., 2016, p. 38; Field, 2005; Kalaycı, 2014, p. 267-268). The presence of autocorrelation was also examined with Durbin Watson (DW) value. Kalaycı (2014, p. 268) pointed out that the DW value between 1.5 and 2.5 indicates no autocorrelation. In the current study, the DW value was 1.72 for student engagement, 1.87 for teaching strategies, 1.76 for classroom management, and 2.01 for performance. The findings showed that all the assumptions were satisfactory. When evaluating the CFA results, special attention was

paid so that χ2/df rate was less than 5, and RMSEA was less than .08 while CFI and NFI values were higher than .90 (Çokluk et al., 2016, p. 271-272). Intervals were considered in the interpretation of arithmetic means. The range for the scales was identified as "very low" for 1.00 and 1.79, "low" for 1.80 and 2.59, "medium" for 2.60 and 3.39, "high" for 4.40 and 4.19 and "very high" for 4.20 and 5.00. In evaluating the relationships among the variables, the range of 0.0-.30 was considered "low", .31-.70 "medium" and .71-1.0 "high" (Büyüköztürk et al., 2012, p. 92).

Ethical Statement

This study was conducted with the permission of Social and Human Sciences Ethics Committee of SDU dated 09/06/2020 issued 91/4.

Findings

The results about teacher leadership, teacher self-efficacy, teacher performance and arithmetic mean and standard deviation for all dimensions were presented in Table 1.

Table 1

Arithmetic Means and Standard Deviations

Scale	Factors	$\bar{X}$	*Ss*
TLS $\bar{X}$= 3.93	1. OD	3.89	.64
	2. PD	4.02	.77
	3. CwC	3.88	.77
TSES $\bar{X}$= 3.92	4. SE	3.76	.86
	5. TS	4.02	.81
	6. CM	3.98	.86
JPS	7. Perf	4.05	.79

N=401 (OD: Organizational development; PD: Professional development; CwC: Cooperation with colleagues; SE: Student engagement; TS: Teaching strategies; CM: Classroom management; Perf: Performance)

As Table 1 shows, teacher leadership, teacher self-efficacy and teacher performance were at a "high" level. Furthermore, a high level of perception was observed in all factors. The results of correlation analysis about teacher leadership, teacher self-efficacy and teacher performance were presented in Table 2.

Table 2

Correlations between Variables

Factors	1	2	3	4	5	6	7
1. OD	-						
2. PD	.74**	-					
3. CwC	.70**	.75**	-				
4. SE	.40**	.40**	.46**	-			
5.TS	.52**	.62**	.52**	.47**	-		
6.CM	.48**	.62**	.52**	.36**	.56**	-	
7.Perf	.61**	.64**	.57**	.52**	.61**	.55**	-

**p<.01; N=401 (OD: Organizational development; PD: Professional development; CwC: Cooperation with colleagues; SE: Student engagement; TS: Teaching strategies; CM: Classroom management; Perf: Performance)

As Table 2 shows, correlation coefficients of OD with SE (r=.40; p<.01), TS (r=.52; p<.01), CM (r=.48; p<.01) and perf (r=.61; p<.01); PD with SE (r=.40; p<.01), TS (r=.62; p<.01), CM (r=.62; p<.01) and perf (r=.64; p<.01); CwC with SE (r=.46; p<.01), TS (r=.52; p<.01), CM (r=.52; p<.01) and perf (r=.57; p<.01) indicated positive significant correlations among all factors at a moderate level. Multiple linear regression analysis results showed the predictability of all dimensions of teacher leadership on self-efficacy and performance as presented in Table 3.

Table 3

Multiple Linear Regression Analysis Results

	Student Engagement			Teaching Strategies			Classroom Management			Performance		
	B	*t*	R^2	*B*	*t*	R^2	*B*	*T*	R^2	*B*	*t*	R^2
			.22			40			40			46
OD	.169	1.806		.116	1.496		.006	.069		.327	4.561*	
PD	.093	1.103		.524	7.524*		.589	7.957*		.357	5.528*	
CwC	.346	4.380*		.091	1.392		.145	2.094*		.132	2.186*	

N=401; *p<.05.

As Table 3 shows, three dimensions of teacher leadership explained 22% of the total variance (F=38.873, p<.05) regarding teachers' perceptions of student engagement. Only CwC (β=.346, p<.05) significantly predicted SE. In terms of TS, all dimensions of teacher leadership together explained 40% of the total variance (F=89.774, p<.05). It was found that only PD (β=.524, p<.05) was a significant predictor of TS. Considering teachers' perceptions of CM, all dimensions of teacher leadership together explained 40% of the total variance (F=88.415, p<.05). It was also found that PD (β=.589, p<.05) and CwC (β=.145, p<.05) significantly predicted CM. Finally, all dimensions of teacher leadership together explained 46% of the total variance (F=112.545, p<.05) in terms of

teachers' perceptions of performance. It was further noted that OD (β=.327, p<.05), PD (β=.357, p<.05) and CwC (β=.132, p<.05) significantly predicted performance.

Discussion

In this study, the relationships among teacher leadership, teacher self-efficacy and teacher performance were examined. The participants were 401 teachers working in Altındağ, Ankara. The findings showed that the perceptions of teacher leadership were high. Various studies supported this finding (Beycioğlu & Aslan, 2012; Cansoy & Parlar, 2018; Öntaş & Okut, 2017). In other words, the perceptions about teacher leadership were found to be positive. Teachers' perceptions of *professional development,* in particular, were found to be higher in teacher leadership. This can be interpreted as the teachers' willingness to communicate effectively with their colleagues, exhibit behaviors open to learning, follow innovations, and take responsibility for the development of the school. In addition, the perceptions of *cooperation with colleagues* and *organizational development* were found to be lower than *professional development* in the study. This finding was consistent with previous research findings (Kılınç & Recepoğlu, 2013; Yiğit et al., 2013). It follows that teachers *cooperating with colleagues* hold themselves responsible for their development, share their own experiences to increase their professional competencies, direct and support them. Teachers' lower perception of *organizational development* can be regarded as avoiding the process of participating in school administration and official tasks and participating in environmental activities. Participation in the decision-making process within the organization is a factor that enhances the quality of organizational functioning. This process might positively affect the individual's commitment to the organization and the perception of organizational citizenship. It was asserted that decisional participation supports organizational development (Aslan & Ağıroğlu Bakır, 2015). However, the centralized structure of the education system does not considerably allow the spread of distributed leadership behaviors in school administration. By holding the authorities and responsibilities, the administration might therefore prevent other teachers from reaching collaborative opportunities that might enable them to improve their leadership qualities. This finding was found to be similar to the findings of previous studies (Sawyer, 2005; York-Barr & Duke, 2004). In addition, teachers' reluctance to take part in official duties and other environmental activities may result from intensive teaching activities. Such similar activities mostly do not yield tangible returns (e.g., certificate of achievement, service score, etc.). They are perceived as a waste of time and might increase teachers' reluctance.

This study found that teachers' perceptions of self-efficacy were high. This finding accords with previous literature (Demir, 2018; Kutluca, 2018). According to these findings, teachers expressed their self-efficacy levels as positive. In other words, teachers believed that they had the skills necessary to achieve a goal. This may indicate teachers' ability to reflect the competences forming the basis of the teaching profession, such as pedagogical-field expertise and general knowledge-ability while performing their duties related to their jobs.

Similarly, teachers exhibited their performances at a high level in the study. This finding was also supported by some studies (Akçekoce & Bilgin, 2016; Akman, 2018; Bakker & Bal, 2010; Büyükgöze & Özdemir, 2017; Limon & Sezgin-Nartgün, 2020;

Özdemir & Gören, 2017; Özdemir & Yirmibeş, 2016; Özgenel & Aktaş, 2020; Özgenel et al., 2020). In studies investigating teacher performance in recent years, mostly high perception of performance has drawn attention. Various conditions improved in schools relatively considerably compared to the past might account for this. In other words, the developments enhancing teachers' performance can be a relative increase in the insufficient opportunities for teachers to participate in decisions concerning them (Burton et al., 2008), increasing the school's educational power by completing norm staffing of teachers, facilitation of classroom management thanks to the decrease in student numbers (Akalın, 2015) and a more intense encounter of students with technology-based rich learning experiences (Tosuntaş, 2017).

The relationships among variables were also examined in this study. The findings showed that teacher leadership behaviors had significant positive relationships with student engagement, teaching strategies, classroom management and teacher performance. The fact that teacher leaders were in *cooperation with colleagues* can be considered as a reflection of leadership. Teacher leaders convey their innovative learning experiences to other teachers by emphasizing cooperation in informal relations (Muijs & Harris, 2003). This accordingly contributes to teachers' *professional development* and thus to the development of schools (Pounder, 2006). It also positively affects teachers' classroom management skills and teaching strategies. It was asserted that teacher leadership was expressed as an element that increases teachers' professionalism (Crowther et al., 2009). Similarly, Jackson and Bruegmann (2009) emphasized the importance of collaboration in helping employees deal with uncertainties about educational practices at school and in increasing instructional quality. The changes that leadership creates on the organization and its employees can be examined in many ways. Leadership behaviors can be viewed as an important element behind many positive or negative outputs in the organization. In particular, it is striking that the leadership behaviors of teachers that support the professional learning process significantly affect teaching quality, student learning and institutional development (Hallinger et al., 2017; Zheng et al., 2018).

As one of the dimensions of teacher leadership, *organizational development* was found to be an important predictor of performance. According to the findings, the quality of teachers' behaviors for the development of the school can be viewed as performance. That is, the behaviors teachers perform voluntarily and in administrative duties might increase teacher visibility in schools. This may indicate task performance. Performance has a multidimensional and complex structure, affected by many individual and environmental factors. In this sense, it may be difficult to know which dimension of organizational development affects performance. The current study examined performance in general. However, the relationship in this study can be handled through contextual performance. According to the literature, contextual performance is voluntary behavior excluded in the job description of employees. It supports the psychological and social environment of the organization (Onay, 2011). Expressions such as voluntariness, effort, optional behaviors and team performance are frequently emphasized to explain contextual performance (Robbins & Judge, 2012). The mentioned expressions are the administrative support displayed by the teachers and participation in the school's relations with environmental factors, etc., in organizational development associated with such actions.

Furthermore, it was found that organizational development did not predict student engagement, teaching strategies and classroom management among the variables. This might be due to the fact that organizational development is largely caused by administrative duties and environmental factors that affect the school. That is, the dimensions unpredictive of the organizational development emphasized the educational process in the classroom. It is further linked with such actions as formal-informal empowerment in the school, making efforts for the recognition of the school in the society, and exhibiting voluntariness for the participation of environmental factors in the education process. Moreover, this may imply that teachers mostly direct their energies to classroom activities and are not very interested in administrative routines in school. The reason for this may be the perception of waste of time and lack of motivation for related jobs. To prevent this drawback, teachers' perceptions can be raised by developing practices that might encourage teachers who take responsibility for school business administration and environmental relations by school administrators.

Herzberg et al. (1959) stated that meeting the individual development needs of teachers is related to their performances. In other words, teacher leaders exhibiting behaviors towards the *professional development* of other teachers might be considered to positively impact their educational efficiency by providing them with new learning experiences. Similarly, leadership behavior improved teacher performance (Abu Nasra & Heilbrunn, 2015). Transformational leadership was found to have significant effects on teacher performance (Fernet et al., 2015). Pounder (2006) asserted that transformational leadership and teacher leadership had similar behavioral patterns. This can be acknowledged as a finding that supports the predictability of teacher leadership on performance in the current research.

Additionally, it was claimed that teachers' expressing their colleagues' achievements or high performances promoted self-efficacy development (Tschannen-Moran & Johnson, 2011). In brief, leader teachers are believed to strengthen teachers' self-efficacy beliefs through verbal persuasion. Considering that self-efficacy is an individual's belief in achieving success, an increase in teachers' educational skills is predicted to support their self-efficacy. In addition, no predictive effect was found, although an indirect interaction was expected between professional development and student engagement in the study. This may be due to factors related to professional development. Professional development means having the power to increase the motivation of teachers, enabling them to discover their potential and having a more participatory attitude within the school. There is an incentive for teachers to be an important part of schools. Also, student engagement mostly emphasizes practices for the positive development of student behavior in the classroom. In other words, it is mainly related to behavior management.

Moreover, it was found that *cooperation with colleagues* significantly predicted such dimensions of self-efficacy as performance, classroom management and student engagement. The behaviors of teacher leaders to enhance the instructional competence of their colleagues might also be said to affect the instructional quality of teachers positively. Various studies on the importance of collaboration among teachers showed that professional collaboration was a significant predictor of teacher self-efficacy (Duyar et al., 2013; Sehgal et al., 2017). In this regard, Guo et al. (2012) pointed out that the quality of teaching had a positive relationship with teachers' self-efficacy

perceptions. Supporting these findings, Olsen (2008) also stated that teacher self-efficacy was positively interacted with teacher performance.

Moreover, Sehgal et al.'s study (2017) was considered important in terms of providing a holistic perspective to the current study findings. In this study, the effectiveness of teachers' self-efficacy perceptions could be increased with the cooperation between colleagues and the support of school administrators. It was further found that cooperation with colleagues did not significantly predict teaching strategies. Cooperation with colleagues indicated a positive interaction with other teachers in terms of both educational and instructional processes. In this process, CwC was emphasized to increase the mutual competence of teachers. Instructional strategies mostly refer to the in-class application process. The lack of predictability among the variables may be due to the more superficial and formal relations between teachers rather than the cooperation of teachers towards the implementation process. In other words, cooperation with colleagues may be realized only through sharing documents (e.g., exam papers, course materials, reports, etc.). In this case, there may not be interactions related to the applied teaching process.

Conclusion and Implications

In conclusion, the study showed that teacher leadership was an important variable to explain teacher performance. In other words, the development of teacher leadership in schools was highly effective on the development of teachers' performance. Teacher leadership was also found to have partial effects on self-efficacy on the basis of dimensions. To increase the interaction and professional collaboration between teachers, interdisciplinary interaction can be developed through meetings organized by teachers in their areas of expertise during out-of-school times. Moreover, a formal (policy makers) or informal performance system can be created to reveal the leadership characteristics of teachers. With this system, teachers' self-confidence and competence can be enhanced, and the way to contribute to their environment can be paved. This study was carried out in state educational institutions. Therefore, taking the opinions of teachers working in private education institutions can provide a holistic view of leadership, self-efficacy, and performance. In addition, examining the relationship between teacher leadership and different organizational behavior outcomes such as motivation, commitment and burnout can contribute to the literature. As another suggestion, examining how teachers' leadership tendencies are handled in different working groups (school principal, student, etc.) and with various research methods may reveal rich perspectives on the concept.

Limitations

This study has various limitations. First, the study group was located in Altındağ, Ankara, thus making it difficult to generalize the findings. Second, the teachers' responses to the scales might be socially desirable, therefore weakening their objectivity. This might be because teachers made their own self-evaluations when exhibiting behaviors or attitudes in the scales. Third, more comprehensive findings might be obtained by qualitative or mixed methods instead of quantitative methods.

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