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Research Article

Analyzing Student Drawings of Cosmology Concepts

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Abstract: Drawing technique is an effective technique used to reveal the thoughts and misconceptions of science concepts created by students. The aim of this study is to reveal the thoughts and misconceptions of secondary school 7th grade students about cosmology concepts in the subject area of 'Earth and Universe' in science course. The research was organised in case study design, which is one of the qualitative research methods. Fourteen (7 female, 7 male) 7th grade students in a state secondary school were selected as participants by criterion sampling method. The data were collected with the help of a drawing form designed by the researcher taking into account the cosmology topics and achievements in the subject area of 'Earth and Universe' in the 2018 curriculum of the 7th grade science course, and the data obtained were analysed by content analysis method. The most important finding of this study is that visual-aesthetic concern in student drawings is more important than scientific accuracy. In addition, it was determined that students explained cosmology concepts by associating them with different concepts, were influenced by daily life, textbooks and audio-visual educational materials while creating their drawings, and had misconceptions about basic astronomy concepts. It is thought that this study will contribute to the field by revealing the findings about the misconceptions of secondary school students as well as their thoughts and conceptions about cosmology concepts.

Keywords: Cosmological Concepts, Student Drawings, Misconceptions, Case Study

1.Introduction

Starting from childhood, people learn, categorise and discover the relationship between concepts in their minds. Thus, they give meaning to their knowledge, reorganise and restructure it. The process of learning and restructuring concepts in the mind of human beings continues throughout life (Gödek et al., 2019). Concepts, which are the basic elements of thought processes, are also the main elements that form the cognitive structure of individuals (Klausmeier, 1992). Images are created in our minds by determining the different aspects of concepts and bringing together their common features (Laçin Şimşek, 2022). In science education, while learning scientific concepts, students spontaneously pass through an intertwined information transition stages in which the ideas they initially acquired and the intended information coexist (Liu, 2021). For this reason, it is important to determine what kind of understanding students have about the concepts. Some of the basic concepts in the field of science are concepts that we encounter in daily life, some of which we easily experience and some of which we do not have the chance to experience (Görecek Baybars & Çil, 2019). The fact that science subjects and concepts are complex and abstract makes it difficult for students to visualise these subjects and concepts in their minds (Düşkün, 2011). Students postpone learning abstract concepts that they have difficulty in learning or choose to place them in the schemes they have previously created. For this reason, they cannot learn or mislearn the new concepts they encounter. A concept that is fundamentally mislearned is the precursor of the next mislearning (Direkci, 2014). Mislearning brings misconceptions along with it. A misconception is a systematic, permanent, widespread understanding and explanation that is resistant to change, systematic, permanent, and common, unlike what is accepted scientifically in science education (Gödek et al., 2019). It is not possible to identify and eliminate these misconceptions with ordinary activities, and there are many techniques that can be used to eliminate misconceptions (Laçin Şimşek, 2022). Students' drawings are a method used to identify misconceptions and understandings in science research (Çardak, 2009; Dikmenli, 2010). For this reason, in the process of

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teaching science subjects and concepts, it is important to determine students' thoughts and comprehension about these subjects and concepts as well as their misconceptions through drawings One of the specific objectives of the 2018 Science Curriculum is 'to provide basic knowledge about astronomy, biology, physics, chemistry, earth and environmental sciences, and science and engineering applications' (MoNE, 2018). This aim is stated in the Science Course Curriculum of the Turkish Century Education Model, which started to be implemented as of 2024, as 'Students to have basic knowledge about physics, chemistry, biology, astronomy, earth and environmental sciences' and 'Discovering that the universe and the world in which they live are a whole of systems and becoming aware that they are a part of this whole' (MoNE, 2024). In this direction, it is aimed to provide students with basic astronomy concepts with the acquisitions in the subject area of 'Earth and Universe' at the 3rd-8th grade levels. When we look at the acquisitions in the 'World and Universe' subject area, it is seen that in addition to basic astronomy concepts, there are also concepts of cosmology (such as star, black hole, galaxy, universe). Cosmology, as a young scientific discipline that has developed rapidly in recent years, can be defined as the general science of the universe or the science of the physical laws of the universe (Goenner, 2010). Dark matter, dark energy, black holes, black holes, early universe, galaxy and formation phases can be given as examples of the subjects that cosmology is interested in (Kayalı & Bakırcı, 2022). When the literature is examined, it is noteworthy that the number of studies on these concepts is high due to the fact that astronomy topics and concepts are suitable for mislearning by students. In the national and international literature on astronomy education (Aksan et al., 2017; Alın & İzgi, 2017; Babaoğlu & Keleş, 2017; Bailey, 2007; Bolat et al., 2014; Bülbül et al., 2013; Can & Görecek-Baybars, 2018) and on the concept of 'Universe', one of the basic astronomy concepts (Aksan & Çelikler, 2019; Bostan Sarıoğlan et al., 2016; Conlon et al., 2017; Çalışkan, 2023; Hansson & Redfors, 2006; Lemmer et al., 2003; Spiliotopoulou Papantoniou, 2007; Uluay, 2020). Looking at the studies in the national literature, it is seen that there are not enough studies on modern astronomy topics such as big bang and black hole (Kurnaz et al., 2016). In the international literature, although cosmology is one of the commonly taught astronomy topics, there are limited number of studies (Lightman et al., 1987; Prather et al., 2002; Siegal et al., 2004; Simonelli & Pilachowski 2003; Wallace et al., 2012).

When the studies are evaluated, it is seen that the learning-teaching situations of astronomy subjects such as the shape of our planet, the earth and the universe, stars, gravity are frequently preferred by the researchers. However, when evaluated in terms of learning situations, it is understood that the studies are more oriented towards determining misconceptions and determining the level of understanding (Bela et al., 2023; Bitzenbauer et al., 2023; Durukan et al., 2023; Wilhelm et al., 2022). In addition, it is seen that studies on modern astronomy and cosmology topics such as the big bang, the expansion of the universe, and black holes remain in the background (Kurnaz et al., 2016). For this reason, the aim of the study is to reveal the 7th grade secondary school students' thoughts and concepts as well as misconceptions about the cosmology concepts in the subject area of "Earth and Universe" in the science course. It is thought that the study will contribute to future research on cosmology topics and concepts. In addition, the original aspect of this study is the comparison of student drawings of the concepts and the actual visuals of cosmology concepts. The cosmology concepts to be considered in the study were limited to the concepts of star, black hole, galaxy and universe in the subject area of 'World and Universe' in the 2018 science curriculum. In this study, students 'thoughts and comprehension of the cosmology concepts, as well as their misconceptions, were tried to be determined by using the drawing technique and comparing the students' own drawings with the actual visuals of the cosmology concepts. The research questions determined in line with this objective are

a) What are the thoughts and conceptions of 7th grade secondary school students about cosmology concepts?

b) What are the misconceptions of secondary school 7th grade students about cosmology concepts?

c) What are the similarities and inconsistencies that emerge when the drawings of secondary school 7th grade students about cosmology concepts are compared with the actual visuals of the concepts?

2. Method

In the study, the case study design, which is accepted as one of the qualitative research methods, was used to reveal the thoughts and conceptions of secondary school 7th grade students towards the cosmology concepts in the subject area of 'Earth and Universe' in the 2018 curriculum of the science course. Creswell defined case study as a qualitative approach that examines a limited real-life system in depth with different data sources (Creswell, 2021). Case study has distinctive features such as providing originality by establishing a strong contextual relationship between cause and effect, associating analysis and descriptions, emphasising specific events, collecting multiple data and focusing on the natural environment. However, in order to eliminate the ambiguity of 'what the situation corresponds to' that may occur with the preference of this design, the researcher should clarify the unit of analysis used in the study, how he/she defines the situation and the boundaries of the research (Cohen et al., 2021). In this study, the 7th grade secondary school students' thoughts and understandings about these concepts were analysed as a case. Since the determined case contains a single unit of analysis, the research was structured according to the holistic single case design.

2.1. Research context

This study was conducted in a public secondary school in a middle socioeconomic level region. The collection of the study data was completed in 3 weeks (4+4+4=12 lesson hours) in the second semester of the 2023-2024 academic year. Of the total of 12 lesson hours, 4 lesson hours were devoted to student drawings related to the determined concepts and 8 lesson hours were devoted to individual interviews with students.

2.2. Participants

In the selection of the participants in this study, criterion sampling method, which is one of the purposeful sampling methods, was used as a sampling method because it allows in-depth study of the situations. In the selection of the individuals to be included in the study, the status of having seen the subjects and concepts of the 'Earth and Universe' subject area in the 2018 science curriculum and the grade level in which these subjects are included in the curriculum were accepted as criteria. Within the framework of the determined criteria; 7th grade students were selected as participants by accepting that they had the acquisitions in the 5th grade 'Sun-Earth and Moon' unit, 6th grade 'Solar System and Eclipses' unit and 7th grade 'Solar System and Beyond' unit of the 'Earth and Universe' subject area. The participants consisted of 14 volunteers, 7 girls and 7 boys. There is one 7th grade class (n=14) in the secondary school where the study was conducted. Before the application and interviews, the participants were informed about the process, it was stated that participation was voluntary and they could leave the study whenever they wanted.

2.3.Data collection

The data of this study were obtained by drawing form and individual interviews with the students. The drawing form (Appendix A.), which consists of five questions that will enable students to reveal their thoughts and comprehension of cosmology concepts, was prepared by the researcher by consulting expert opinions. The content of the questions in the drawing form was prepared by taking into account the cosmology topics and concepts in the subject area of 'Earth and Universe' in the 7th grade science course 2018 curriculum. In the process of collecting data with the drawing form, each student was given a blank A4 paper about the five concepts determined, and they were asked to think about these concepts, reflect their thoughts on the paper through drawing, and explain their drawings with the expressions they would write under them. The students were given 20 minutes to complete their drawings for each

concept, during which time they used their own pencils, crayons and erasers. Before starting the drawings, the researcher made explanations about the students' drawing skills so that they would not have aesthetic and grade concerns. Data were also obtained through individual interviews in order for the students to reveal their ideas about what they wanted to explain and what they wanted to show in their drawings. During the interviews, care was taken to ensure that the questions directed to the students were of a quality that would allow them to explain their drawings related to each concept.

2.4. Data analysis

In this study, student drawings were determined as the unit of analysis. Content analysis method was used to analyse the data obtained from the data collection tools related to this purpose. Before starting the analysis, a code was assigned to each participant to avoid using the real names of the participants. The randomly ordered student names were numbered from 1 to 14 as 'S.1, S.2, S.3.....S.14'. After collecting the data, the researcher edited the student drawings, the explanations made about the drawings and the transcript texts obtained from the individual interviews to make them suitable for analysis. The drawing form of the disadvantaged student, who was coded as S.12. and participated in the whole process, was eliminated from the data because it was not related to the concepts determined. After editing, the drawings were analysed by considering the level of expression and relationship of the related concept, and then the explanations under the drawings were examined. In the analysis of the drawings, the data obtained were meticulously read twice by the researcher and the first key concepts were extracted. In the next stage, the drawings that were found to have common characteristics and the explanations made by the students about their drawings were brought together to form categories and themes related to the categories. When evaluated from this framework, it can be said that an inductive category-theme determination method was preferred. The determined categories and themes and sample student drawings are given in the findings section. It is known that the explanations under the student drawings are effective in revealing the targeted responses (Carless & Lam, 2014). For this reason, inferences were made about the expressions that students used most frequently while expressing the related concept under their drawings. Sample written expressions of the students for the related concept are given in the findings section. After analysing the drawings and explanations, the drawings were clarified through individual interviews to reveal the points that were not understood in the drawings. The misconceptions found to exist in the students during the individual interviews are presented in Table 1. In the last stage, the poster created with the visuals of cosmology concepts was shown to the students and their opinions about the visuals were taken and they were asked to compare their own drawings with the visuals.

2.5. Trustworthiness

The concepts of credibility and transferability were developed in qualitative research instead of the concept expressed as validity in quantitative research, and the concepts of consistency and verifiability were developed instead of the concept expressed as reliability (Lincoln & Guba, 1985). While revealing the value of a qualitative research, it is very important to provide criteria appropriate to the structure of the research (Arslan, 2022). In order to ensure the credibility criterion of the study, appropriate methods were selected for the purpose, data collection tools and data types were diversified. It was tried to add depth to the study by revealing how much the data support each other with the different data collection tools used. In order to meet the criterion of transferability, the participants to be included in the study were determined through criterion sampling, which is one of the purposeful sampling methods, and the participants who met the specified criteria were included in the study. Each stage of the data analysis process was explained in detail, examples from the participants' own drawings and written expressions were included while interpreting the data, and validity was tried to be ensured by directly including the statements in the interviews regarding the drawings. In order to ensure the consistency criterion, expert opinions were consulted in the formation of the categories and themes

reached as a result of the data analysis. The codes, categories and themes obtained from the drawings created by the students were evaluated by a competent instructor who has carried out studies in the field of science education, and necessary corrections and improvements were made as a result of the evaluation and suggestions.

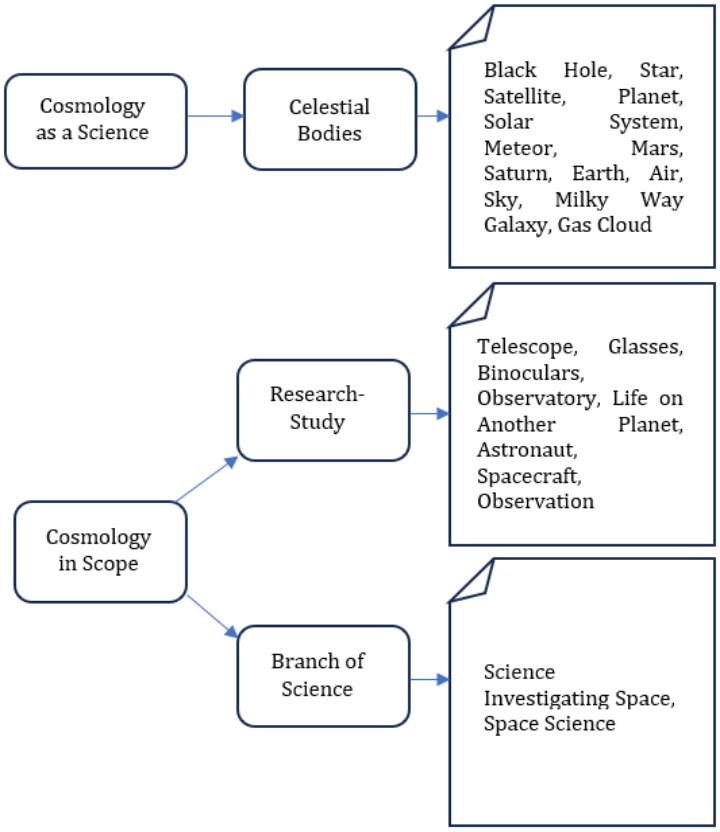
3. Findings

The findings obtained as a result of the analysis of the data are given under the headings of the findings related to the students' drawings, the findings related to the written explanations about the drawings and the findings related to the individual interviews, respectively.

3.1. Findings related to students' drawings

Figure 1

Codes, Categories and Themes Obtained from Students' Drawings Related to the Concept of "Cosmology"



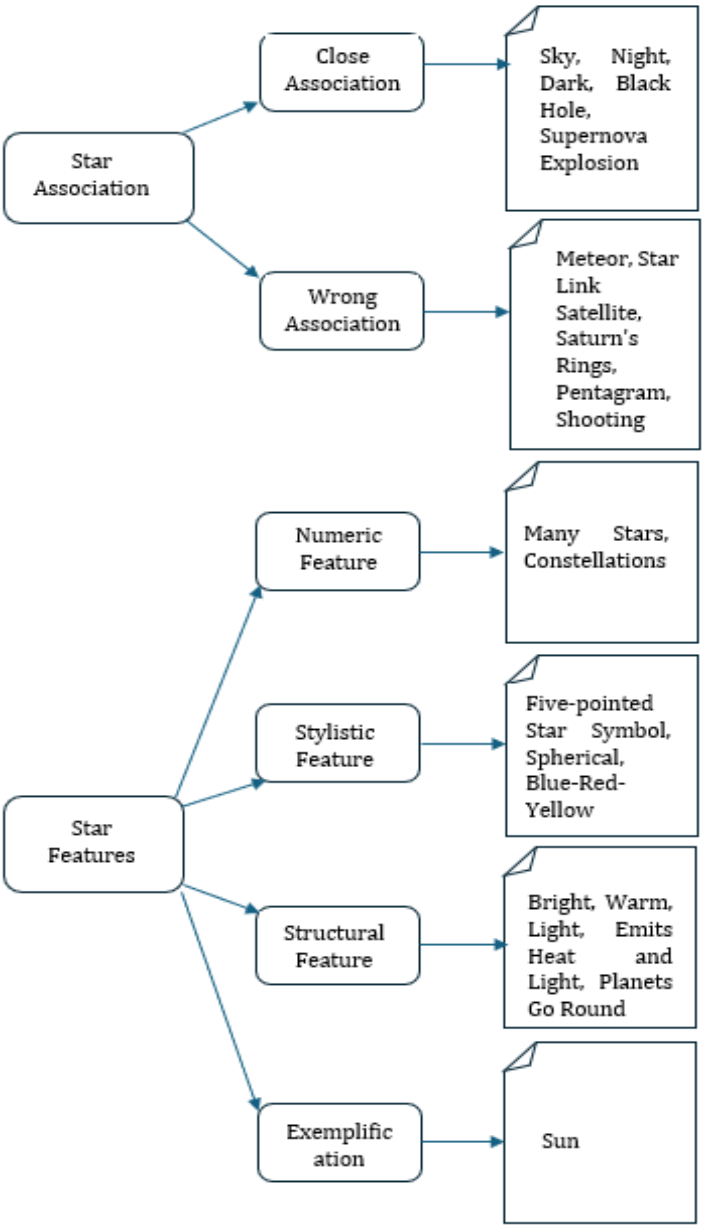
When Figure 1 is analysed, it is seen that the drawings related to the concept of cosmology are grouped under two themes as 'Cosmology as Science' and 'Cosmology as Scope'. The findings related to the theme of 'Cosmology as Science' showed that students made drawings coded as 'telescope, glasses, binoculars, observatory, life on another planet, astronaut, spacecraft, observation'. The findings related to the theme of 'Cosmology as a Scope' showed that students made drawings coded as 'black hole, star, satellite, planet, solar system, meteor, mars, saturn, earth, air, sky, milky way galaxy, gas cloud'. Sample student drawings of these findings are given below.

Figure 2

Sample Drawings of Cosmology as Science (S.14) and Cosmology as Scope (S.6) Category

Figure 3

Codes, Categories and Themes Obtained from Students' Drawings Related to the Concept of "Star"



When Figure 3 is analysed, it is seen that the drawings of the star concept are grouped under two themes as 'Star Associations' and 'Star Properties'. The findings related to the 'Star Associations' theme showed that the students made drawings coded as 'sky, night, darkness, black hole, supernova explosion, meteor, Star Link satellite, saturn rings, pentagram symbol, shooting star'. The findings related to the 'Star Properties' theme showed that students made drawings coded as 'many stars, constellation, pentacle symbol, spherical, blue-red-yellow spheres, bright, hot, light, emits heat and light, planets circling, sun'. Sample student drawings of these findings are given below.

Figure 4

Sample Drawings of Star Associations (S.1) and Star Properties (S.2) Category

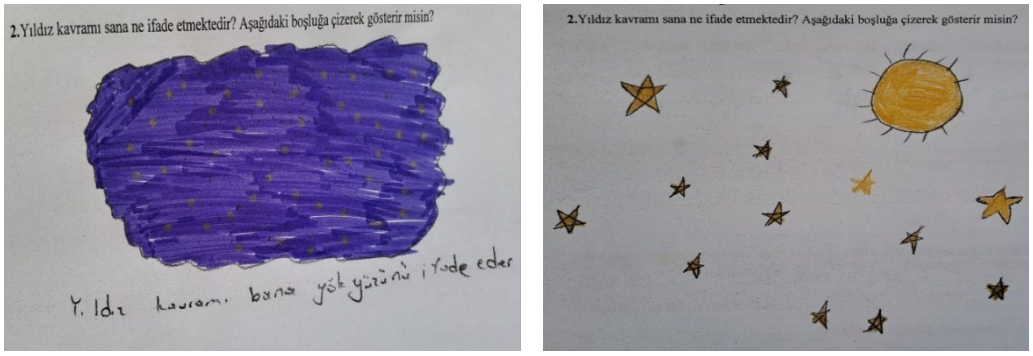
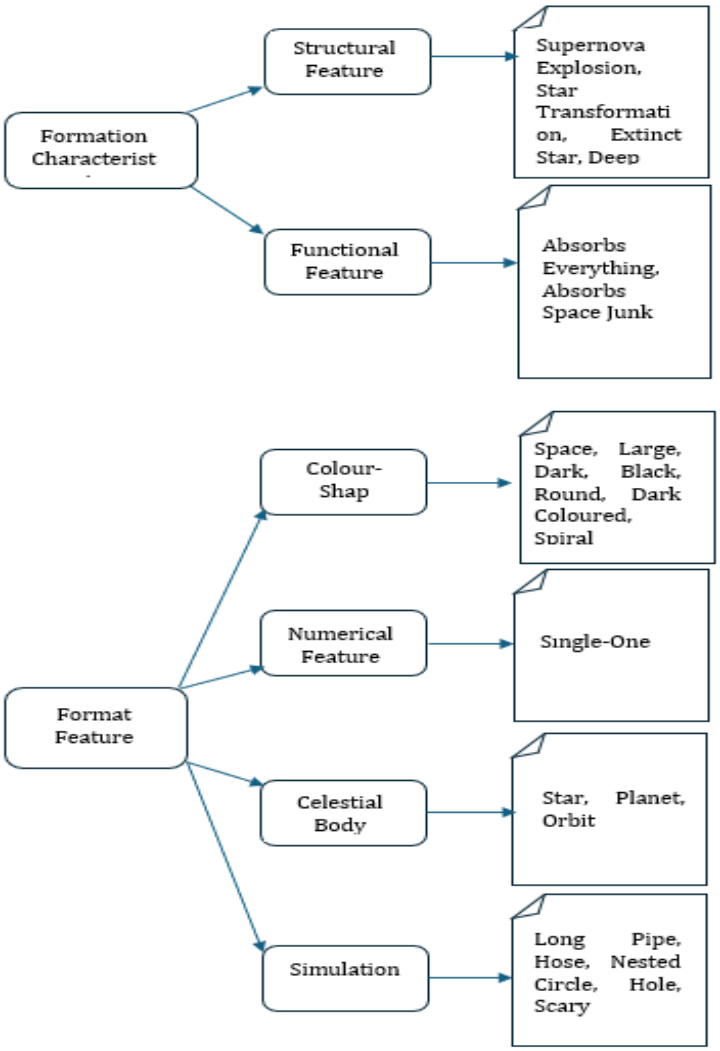


Figure 5

Codes, Categories and Themes Obtained from Students' Drawings Related to the Concept of "Black Hole"



When Figure 5 is analysed, it is seen that the drawings of the black hole concept are grouped under two themes as 'Formation Feature' and 'Form Feature'. The findings related to the 'Formation Feature' theme showed that the students made drawings coded as 'supernova explosion, star transformation, star whose life is over, infinite, rotating, deep, pulls everything into itself, pulls space junk into itself'. The findings related to the 'Shape Feature' theme showed that the students made drawings coded as 'space, big, dark, black, round, dark colour, spiral, spherical, single, one, star, planet, orbit, long pipe, hose, intertwined circle, hole, scary'. Sample student drawings of these findings are given below.

Figure 6

Sample Drawings of the Formation Feature (S.5) and Form Feature (S.7) Category

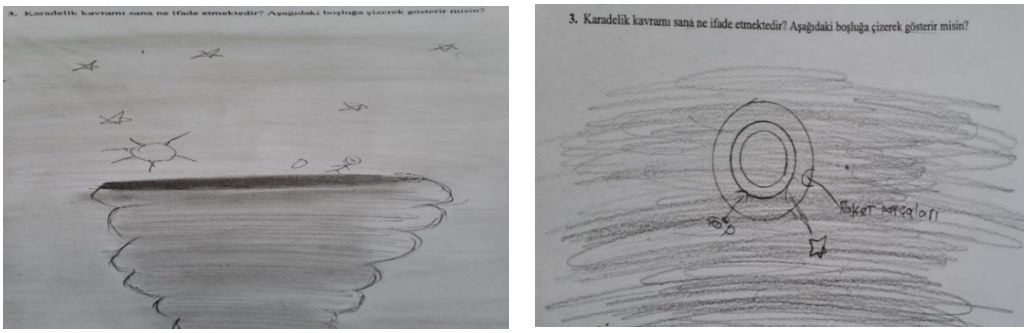
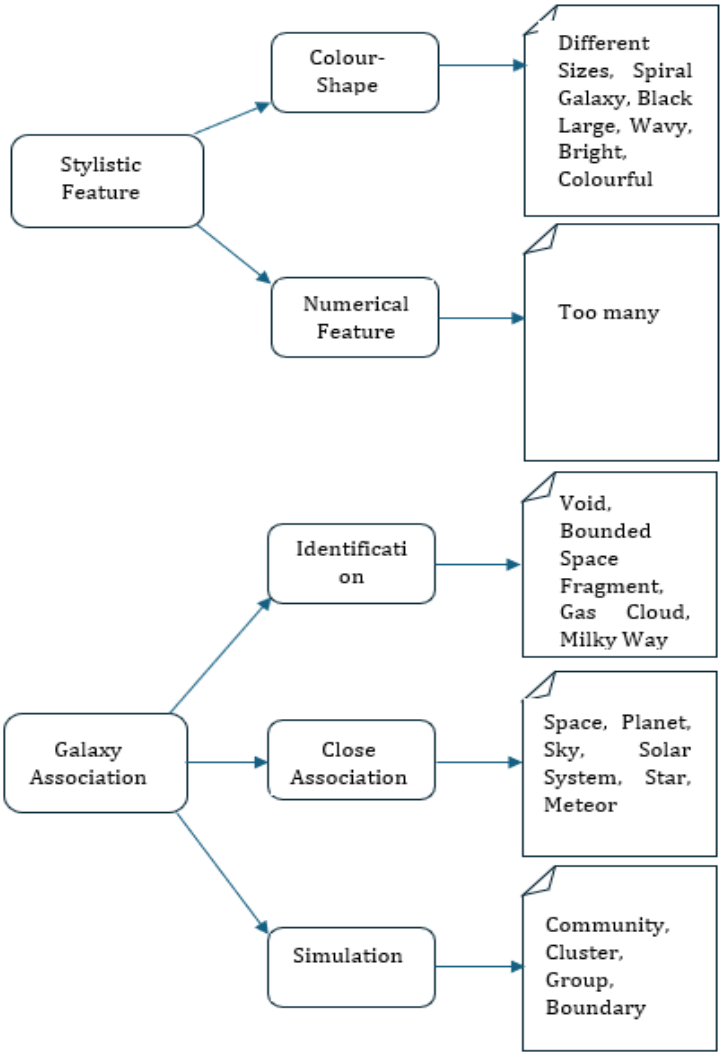


Figure 7

Codes, Categories and Themes Obtained from Students' Drawings Related to the Concept of "Galaxy"



When Figure 7 is analysed, it is seen that the drawings of the galaxy concept are grouped under two themes: 'Galaxy Association' and 'Formal Feature'. The findings related to the theme of 'Galaxy Association' showed that the students made drawings coded as 'space, limited piece of space, gas cloud, Milky Way galaxy, space, planet, sky, solar system, star, meteor, community, cluster, group, boundary'. The findings related to the 'Formal Feature' theme showed that the students made drawings coded as 'round, different sizes, spiral galaxy, big, wavy, bright, colourful, black, many'. Sample student drawings of these findings are given below.

Figure 8

Sample Drawings *Belonging to the Category of Galaxy Association (S.4) and Formal Feature (S.9)*

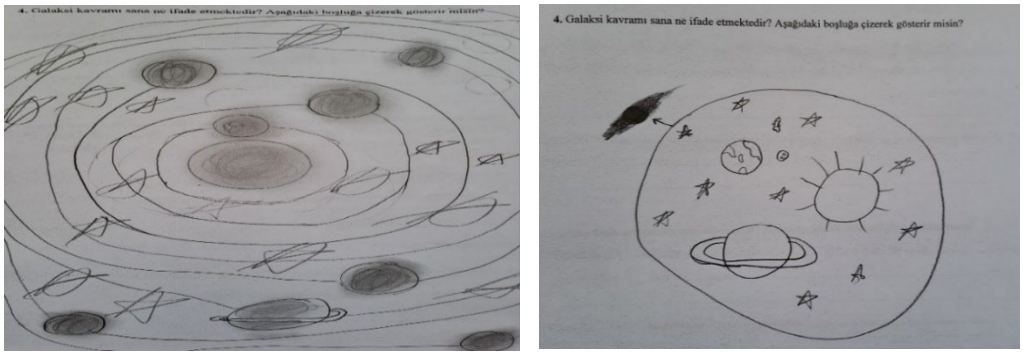
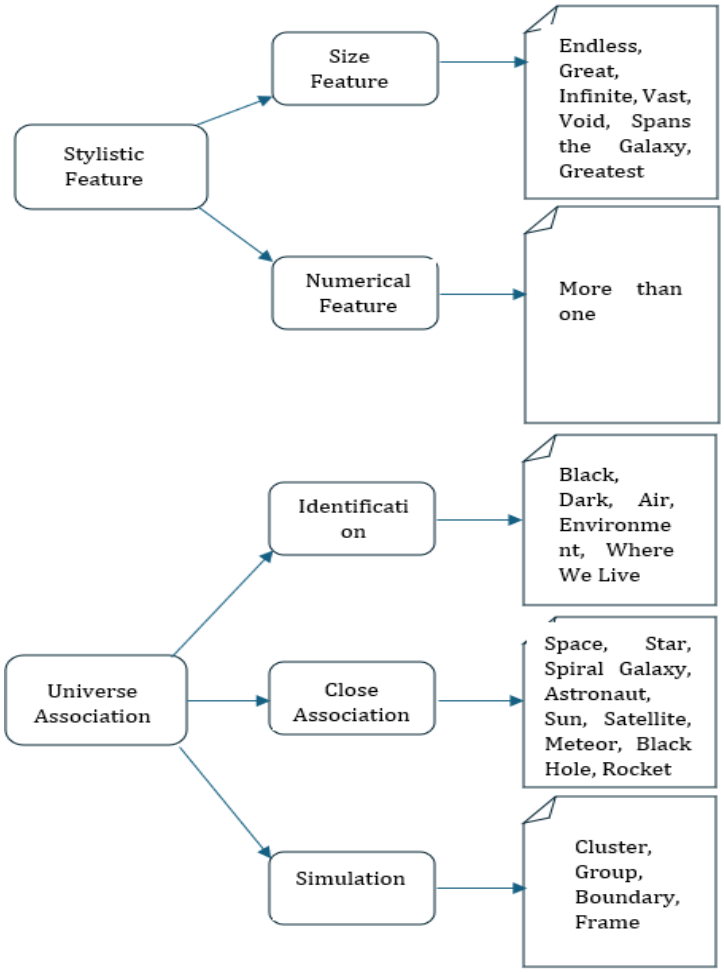


Figure 9

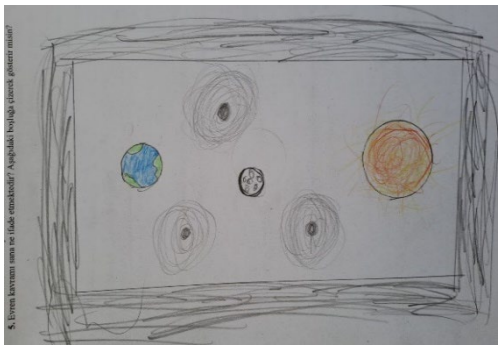
Codes, Categories and Themes Obtained from Students' Drawings Related to the Concept of "Universe"

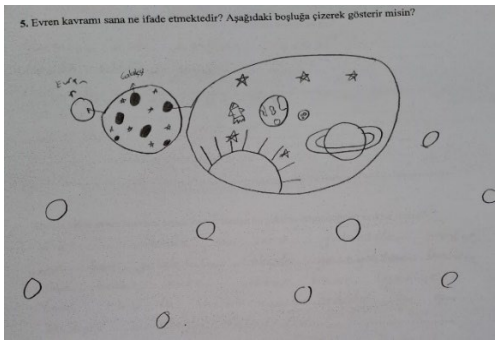


When Figure 9 is analysed, it is seen that the drawings of the universe concept are grouped under two themes: 'Universe Associations' and 'Formal Characteristics'. The findings related to the theme of 'Evocation of the Universe' showed that the students made drawings coded as 'black, dark, air, environment, the place we live in, space, star, spiral galaxy, astronaut, sun, satellite, meteor, planet, black hole, space rocket, Milky Way galaxy, cluster, group, clear boundaries, border, frame'. The findings related to the 'Formal Feature' theme showed that the students made drawings coded as 'no end, big, infinite, vast, space, covers the galaxy, biggest, everything, covers space, more than one'. Sample student drawings of these findings are given below.

Figure 10

Sample Drawings Belonging to the Category of Universe Association (S.10) and Formal Feature (S.9)





3.2. Findings related to students' written explanations about their drawings

In the drawing form where the data were collected, there are questions that allow students to explain the drawings they created about the determined cosmology concepts (What is the reason for drawing a picture like this for the concept of .....? Can you explain the reason for thinking this way?). The answers given by the students to these questions about the concepts of cosmology, star, black hole, galaxy and universe were analysed and the expressions they frequently used to explain the related concept were determined. It was observed that the students mostly emphasised the aspect of investigation and research in their explanations of the concept of cosmology, the shape and colour of the star in their explanations of the concept of star, the feature of being absorbed in their explanations of the concept of black hole, the feature of being big in their explanations of the concept of galaxy and the feature of being infinite in their explanations of the concept of universe. The findings were supported with examples of students' concept explanations.

Table 1

Key Emphasis in Students' Explanations

Concept	Key emphasis in students' explanations	Direct quotations
Cosmology	Investigation and research	*I think cosmology means space science. (S.14)*
Stars	Shape and color	*Stars are round, large objects in space that can be seen at night. (S.13)*
Black holes	Pulling property	*A black hole is a hole in space that goes on forever, sucking in rocket fragments and rubbish. (S.5)*
Galaxies	Large size	*The galaxy includes the solar system and even the Earth. (S.11)*
Universe	Infinite nature	*The universe is infinity. I think of infinity and space. (S.8)*

When Table 1 is examined, students identified the concept of 'Cosmology' with space science and space research in general, while they defined the concept of 'Star' with its shape and colour features. This shows that students tend to construct basic concepts based on their observations. In the concept of 'Black hole', some students associated this concept with 'gravitational force'. In the expressions related to the concepts of 'Galaxy' and 'Universe', students focused on the concepts of magnitude and infinity.

3.3. Findings related to individual ınterviews with students

In the individual interviews with students' drawings, it was found that many students had many misconceptions about the selected cosmology concepts. These misconceptions of the students are given in the table below. The findings were supported with sample student expressions.

Table 2

Participants' Misconceptions about Cosmology Concepts

Misconceptions	**Participant codes**												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**13**	**14**
Five-pointed star symbol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stars come out at night	✓			✓		✓				✓			
Star colour is yellow			✓		✓					✓			
Galaxy = solar system				✓						✓	✓	✓	
Galaxy= nebula											✓		
Space=universe			✓			✓		✓					
Planets in the solar system are aligned in the same order		✓		✓			✓			✓		✓	
Solar system=solar setup			✓										
Venüs=satürn= Jüpiter			✓				✓		✓	✓			
Meteorite= Meteor= Star	✓						✓						✓
Black hole is a hole in the centre								✓					
Black hole= supernova explosion					✓								
Moon craters= pit= hole					✓	✓				✓			
Planets shine						✓							
Saturn's rings are made of stars										✓			
Space is limited					✓				✓				
Heat and temperature			✓					✓		✓			

Some of the student expressions with misconceptions in the table;

'I wanted to draw a hill because the stars come out at night.' (S.1) - (Stars come out at night.)

'Because the planets are actually lined up in such a universe. They have certain distances.' (S.2)- (In the solar system, the planets are aligned in the same line.)

'This concept brings space to my mind, that is, the universe comes to my mind.' (S.3)- (Space=Universe)

'I drew stars, then I drew the solar system, then I drew a rocket.' (S.3)- (Solar System= Solar System)

'Teacher, the sun warms us up, it emits heat.' (S.3)- (Heat and temperature)

'This is what I drew in space; Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. Milky Way galaxy.' (S.4)- (Galaxy= Solar system)

'I drew the sign that came to my mind because it is a shape that everyone knows.' (S.6)- (Five-pointed star symbol)

'Anyway, meteorites are also a star, but there, for example, I drew a little more to increase the number of stars.' (S.7)- (Meteorite= Meteor= Star)

'I made it like this because the planets rotate in order around the sun.' (S.7)- (In the solar system, the planets are in the same order.)

'When I thought of a black hole, I thought of it as a hole.' (S.8)- (Black hole is a hole in the centre.)

'There are stars (rings) around it (Saturn).' (S.10)- (Saturn's rings consist of stars.)

'Those drawings are the heat, the heat coming from the sun, the reflected thing.' (S.10)- (Heat and temperature)

'Yes, teacher, I was going to draw all the planets in the Milky Way galaxy and this much came to my mind.' (S.13)- (Galaxy= Solar system)

When Table 2 is analysed, it is seen that the misconception identified in all of the students is that the star shape is similar to the pentagram symbol. It is also seen that the misconception 'the planets in the solar system are aligned in the same order' is present in many students. Another remarkable finding is that there is no student who does not have a misconception. It is seen that students have at least one misconception about the subject.

4. Conclusion and Discussion

In this study, it was aimed to reveal the 7th grade middle school students 'conceptions and misconceptions about the concepts of cosmology in the subject area of "Earth and Universe" in the science course and to determine the similarities and inconsistencies between the actual visuals and the students' drawings.

As a result of the research, 3 categories belonging to the concept of cosmology and 2 themes related to these categories, 6 categories belonging to the concepts of star and black hole and 2 themes related to these categories, 5 categories belonging to the concepts of galaxy and universe and 2 themes related to these categories were revealed. In the students' expressions related to their drawings, it is seen that they explained the concept of cosmology by emphasising the concept of investigation-research, the concept of star by emphasising the shape and colour of the star, the concept of black hole by emphasising the feature of being absorbed, the concept of galaxy by emphasising the feature of being big and the concept of universe by emphasising the feature of being infinite. In the individual interviews,

misconceptions about cosmology and basic astronomy concepts were identified in many students. Another interesting result was that aesthetic concerns were more important than scientific accuracy in students' drawings. When the students' drawings were compared with the actual visuals of the concepts, some similarities and inconsistencies were found. The students expressed the concepts of cosmology, star, galaxy, black hole and universe not by themselves but by associating them with other concepts. The fact that they associated the concept of cosmology with tools such as telescopes, binoculars and glasses can be explained by the fact that they perceived this concept as the study and research of space. The presence of sky, sun, star and planet drawings in the drawings of the concept of cosmology shows that they associate this concept with celestial bodies. The fact that students expressed the concept of cosmology by associating it with other concepts and basing it on non-scientific knowledge can be explained by the fact that this concept is not directly included in the 7th grade science textbook. When the students' drawings of the concept of star were evaluated, it was noteworthy that most of them used the five-pointed star symbol. This result can be attributed to the fact that the students were inspired by the star symbol in our official flag and frequently encounter it in their daily lives. Similarly, Çakır (2020) found that the symbol on our official flag was effective in the formation of 3rd and 4th grade students' mental perceptions of the Sun and the Moon. Another point that draws attention in the drawings is that the Sun is represented as spherical, large and bright by colouring with a highlighter, while other stars are shown small with a five-pointed symbol. When the students' drawings and individual interviews were compared, it was observed that although they knew scientifically that the star shape was spherical, they used the five-pointed star symbol while drawing. In his study, Direkci (2014) included the views of students who stated that the Sun is spherical and in yellow-orange-red tones. In the written explanations of the students' drawings related to the star, it is seen that the expression sky is frequently mentioned. This situation can be associated with the fact that they see the Sun during the day and distant stars at night in the day and night cycle that occurs as a result of the daily movement of the Earth. Another point that emerged as a result of the interviews was that the students described the property of stars as heat and light sources as ‘emitting heat’ and that they had misconceptions about the concepts of heat and temperature. In addition, students associated comets and meteorites with stars. One student thought that the rings of Saturn were formed by stars. The most important finding that emerged from the analysis of the students' drawings related to the concept of galaxy was that they used galaxy and solar system interchangeably and reflected the solar system instead of the galaxy in their drawings. In the drawings of the solar system, it was observed that the planets were drawn one after the other and orbital lines were included. In the interviews, students stated that they had seen this representation in science textbooks and videos used as educational materials. This finding coincides with the finding of Çoramık and Özdemir (2021) that the examples in the students' drawings are in parallel with those in the textbooks. In their study, Görecek Baybars and Çil (2019) stated that very few students stated that the expression of the solar system can be considered scientifically correct, and that students mostly drew planets in order. This situation shows that visual tools used as educational materials can cause misconceptions in students and misplacing concepts in their minds. Students did not include the term galaxy when defining the concept of galaxy. Although the concept of galaxy is also included as galaxy in the 7th grade science textbook taught in state secondary schools in the 2023-2024 academic year, the concept of galaxy was not encountered in the students' statements. It is seen that the students only knew the Milky Way galaxy as an example of a galaxy and did not express any opinion about galaxy types. While spiral galaxy was included in student expressions, elliptical and irregular galaxy types were not used by the students. The use, size and selection of the visuals in the textbook (MoNE, 7th grade science textbook, pages 37, 38) may be effective in this situation. Another one of the students' ideas about the concept of galaxy is that galaxies have borders. The galaxy was drawn as a cluster including celestial bodies by most of the students. It is noteworthy that many students drew the size of galaxies and stars equal, and even drew stars larger than galaxies. This situation can be attributed to the incorrect ordering of the order from the smallest astronomical structure, the earth, to the largest structure, the universe,

in the students' minds. When the students' drawings related to the concept of black hole were evaluated, the most common expressions were that the black hole was really a hole and that it sucked everything into it. Some of the students expressed black holes as scary. This can be explained by the fact that it is not known what happens to the objects entering the black hole after they pass the event horizon. In their study, Sadıkoğlu et al. (2022) stated that students had ideas about the strong gravitational effect of black holes. In individual interviews, there were also students who made scientific explanations such as black hole is a phase of the stellar life process. When the students' drawings related to the universe are analysed, it is seen that they tried to draw the universe by associating it with space. While they expressed the space as a frame with clear boundaries, they expressed the universe as unlimited. It is noteworthy that the students drew on a very large area by using the whole page. This shows that students think of the universe as very large, very wide and unlimited in their minds. The emergence of the words 'infinity' and 'everything' in the students' explanations about the concept of universe can be attributed to this. In the findings obtained from individual interviews, it is seen that there are students who think that there can be more than one universe. Science fiction films can be shown as the source of this situation. The fact that only two students included the information that the universe is expanding shows that the students' knowledge about the universe is incomplete and their thoughts about this concept are far from scientific. With the acceptance of astronomy as a popular science, the presence of sources containing correct and incorrect information may have led to the emergence of unscientific thoughts in students. When all of the cosmology concepts are evaluated, it is seen that they are tried to be explained by using drawings of the Earth, Moon and Sun. The reason for this may be the students' existing knowledge of the "Sun-Earth-Moon" unit in the 5th grade "World and Universe" subject area. It is surprising that students mostly preferred Earth and Saturn when drawing planets despite the increasing studies and interest in Mars in recent years. In addition, the fact that they called Saturn as Jupiter in individual interviews shows that they misunderstood the names of the planets. The reason for this may be that both planets are gaseous and large planets.

Although it was observed that the students frequently preferred the five-pointed star symbol in their star drawings, they were able to identify the star correctly when compared with the real image. The shape and colour feature in the visual enabled them to identify the star correctly. Although they have scientifically correct knowledge, it is thought that the misconceptions that students acquire in childhood continue in later ages. This situation shows that the fixed concepts developed by the students during their past experiences continue at later ages (Çakıcı, 2010). It was observed that the students made incorrect matching when comparing their own drawings with galaxy and black hole visuals, confused galaxy and black hole, and had great difficulty in associating their own drawings of the concept of cosmology with real visuals. This situation can be explained by the fact that cosmology is not a concept included in the science textbook.

5. Recommendations

The findings and conclusions obtained in this study revealed that misconceptions about cosmology concepts are common among students and that students have problems in making sense of concepts based on scientific knowledge. In this direction, various suggestions were developed for science teachers, educators and policy makers.

Science teachers can use teaching approaches such as multiple representation, modelling and conceptual change texts in their teaching processes by taking into account the difficulties experienced by students in making sense of astronomy-based concepts and the misconceptions and inconsistencies identified in the "Earth and Universe" subject area. They can conduct their lessons by supporting them with techniques (e.g. concept map, word association technique, conceptual change text) to eliminate misconceptions. In addition, digital simulations, interactive software and applications, out-of-school environments (e.g. planetariums) can be included in the teaching process in order for students to

establish correct relationships with concepts. In this way, they can support students' observation, reasoning and inference skills in line with the scientific process skills emphasised in the Turkish Century Education Model. Teachers can place the course content in a pedagogical context through interdisciplinary activities and increase critical thinking and scientific awareness. Policy makers, on the other hand, can increase the scientific consistency of the visuals and content in textbooks and make structural arrangements to prevent misconceptions. In addition, pedagogical control of the visuals in textbooks in terms of size, content and meaning can be provided. It is thought that these methods can help students construct concepts more effectively and eliminate misconceptions.

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Appendix. A. Drawing form prepared to examine middle school 7th grade students' drawings of cosmology concepts in the subject area of 'Earth and Universe' in the science course

Instruction: Dear students, I am conducting a study in which I aim to reveal middle school 7th grade students' conceptions and misconceptions about the concepts of cosmology in the subject area of 'Earth and Universe' in the science course. Within the scope of this subject, I will ask you to reflect your thoughts about five concepts with drawings and explain your drawings. I want you to make sure that your drawings *are related to the subject*. Your drawings are important in terms of *content, not artistic*. You can color your drawings as you wish. Your answers will be kept completely confidential and will not be used for any purpose other than scientific research. Your participation in the study is voluntary. Thank you for your contributions.

1. What does the concept of cosmology mean to you? Can you show it by drawing it in the space below?
   a. What is the reason for painting such a picture of the concept of cosmology?
   b. So what do you think the concept of cosmology is? Can you explain why you think this way?
2. What does the concept of star mean to you? Can you show it by drawing it in the space below?
   a. What is the reason for drawing such a picture of the concept of a star?
   b. So what do you think the concept of a star is? Can you explain why you think this way?
3. What does the concept of black hole mean to you? Can you show it by drawing it in the space below?
   a. What is the reason for painting such a picture of the concept of a black hole?
   b. So what do you think the concept of a black hole is? Can you explain why you think this way?
4. What does the concept of galaxy mean to you? Can you draw it in the space below?
   a. What is the reason for painting such a picture of the galaxy concept?
   b. So what do you think the concept of a galaxy is? Can you explain why you think this way?
5. What does the concept of universe mean to you? Can you show it by drawing it in the space below?
   a. What is the reason for drawing such a picture of the universe?
   b. So what do you think the concept of the universe is? Can you explain why you think this way?

Appendix. B. Poster prepared for middle school 7th grade students to compare their drawings of cosmology concepts in the subject area of 'Earth and Universe' in the science course.

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Research Article

Investigation of Postgraduate Theses on Environmental Education in Preschool Field

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Abstract: This study aimed to determine the general tendency of postgraduate theses on environmental education published in the field of preschool education in Türkiye in 2022 and 2023. The data in the study were postgraduate theses on environmental education in the field of preschool education published in full text in the Higher Education Council (YÖK) Theses Center database. The data collected using the transcript analysis method was reported using the PRISMA. The sample of the study was 20 graduate theses accessed from the YÖK Thesis Center database according to the convenience sampling method. A thesis review form was used within the scope of the literature to determine the general tendency of the theses. Descriptive content analysis was used to analyze the data. The reliability of the analysis was ensured according to the consensus of the researchers. According to the findings, it was determined that theses on environmental education were produced equally in both 2022 and 2023, and the majority of these theses were master's theses. In the other findings, the most common topic in the theses was environmental education. According to the findings of the research design, qualitative and mixed (qualitative + quantitative) research design was mostly preferred in theses. The findings of the research group consisted mostly of teachers and preschool students. According to the findings of the sample selection method, the purposive sampling method was mostly used, and according to the data collection tool, the scale was mostly used. The findings of the study were discussed in the light of the literature.

Keywords: Environmental Education, Content Analysis, Preschool Education

1.Introduction

Environmental problems such as the decrease in biodiversity (Naeem, 2002), deforestation (Lawrence et al., 2022), etc., which have been remarkable in the last century, have brought environmental education to the agenda in environmental conferences organized by international organizations such as Stockholm Conference (1972), Tbilisi Declaration (1977). Since environmental education plays an important role in the formation of environmental awareness and environmentally friendly behavior (Erten, 2004), it is important to include environmental education at all levels of education, especially in early childhood education (Educational, Scientific and Cultural Organization, UNESCO, 2017). Environmental education aims to raise individuals with positive attitudes and behaviors towards the environment, that is, environmentally literate individuals (Demir & Yalçın, 2014). In order to form positive behaviors towards the environment, environmental education is a tool for the development of attitudes, values, knowledge and tendencies towards the environment and the establishment of nature-individual relationship (Köseoğlu & Erten, 2022; Ardoin & Bowers, 2020). Environmental education is critical in the preschool education period, where the foundation of the attitudes and behaviors of individuals is laid (Hadela & Andic, 2021; Özkan, 2017). Because in this period, when the foundation of desired behavior is laid, children develop love and empathy for nature; that is, developing their relationship with nature leads to nature-friendly behavior (Erten, 2005). Studies indicate that environmental education in the preschool period encourages individuals to behave in an environmentally friendly manner in adulthood (Chawla, 2020). Rosa et al. (2018) examined the relationship between nature experience and environmentally friendly behavior and found that nature experience acquired in childhood leads to the adoption of environmentally friendly behavior in adulthood.

Environmental education in the preschool period aims to ensure that environmental knowledge and environmentally friendly behaviors are permanent for a lifetime in children during this period when

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learning is fast and curiosity and interest in the environment are intense (Alıcı, 2022). The boundaries, objectives and principles of environmental education were published at the Conference on Environmental Education held in Tbilisi (UNESCO, 1977). These goals set by the International Organization play an important role in shaping environmental education courses. In this case, the question of where countries are in terms of these goals has led them to seek answers through scientific studies. Likewise, studies analyzing environmental education in the world have found that it is important to integrate environmental education with different disciplines and to include new trends in environmental education in the formation of environmental awareness (Masalimova et. al, 2023; Tian et. al., 2024). For example, in the study by Schleicher (1995), it was emphasized that although environmental education in Germany has made progress in the last 20 years, this development has regressed in recent years and should be supported with new and broader perspectives. From this perspective, it can be stated that there is an accumulation of studies on environmental education in preschool education in Türkiye (Özkan, 2017; Taşkın & Şahin, 2008). In these studies, it is seen that issues such as preschool programs, eco-school approach, forest school approach, etc. are emphasized. For example, Sarıbıyık (2022) examined the effect of environmental education on student behavior in the preschool period and concluded that environmental activities positively affected preschool children's behaviors towards the environment. Gülay and Ekici (2010) examined the preschool education program in terms of environmental education and found that the achievements and skills related to environmental education in the program were at a low level. The results of Demir and Yalçın's (2014) study, which examined preschool curriculum in terms of achievements and concepts related to environmental education, support Gülay and Ekici's (2010) study. The contributions of the studies in which various education programs were applied to environmental education were also observed in other studies. In a study in which the education program was examined in terms of the perception of human-environment relationship, the perception of 60-66-month-old preschool children about human-environment relationship changed after the program implementation compared to before the program implementation (Cengizoğlu, 2013). Similarly, Metin (2023) proved that there was a positive change in preschool students' attitudes towards the environment in their studies conducted according to eco-school activities and Uslucan (2016) according to environmental education program practices. Similarly, in another study, it was found that 60-72-month-old children who were included in the sustainable environment education program had higher levels of attitudes and awareness towards the environment than children who were not included in the program (Çakır & Kanak, 2023). In addition to these studies, studies examining preschool education programs in terms of the contribution of various educational approaches to environmental education such as Özer (2023) are quite common in the literature.

In addition to environmental education programs, educational practices, and activities, studies examining the effect of storybooks and/or books prepared with environmental content on environmental education are also found in environmental education studies in preschool field in Türkiye. For example, Özgül (2022) examined 755 picture storybooks for 48-72-month-old children in terms of environmental literacy components and found environmental literacy components in more than half of the picture storybooks. Alıcı (2022) examined the effect of e-book prepared on environmental sustainability together with environmental education and concluded that environmental education integrated with e-book was effective on 57–71-month-old children's environmental sustainability knowledge.

In environmental education studies in the field of preschool education in Türkiye, it is seen that the study group includes preschool teachers and/or pre-service teachers and, to a limited extent, parents and school administrators as well as preschool students. For example, Akalın (2023), in her study on the views of preschool teachers on environmental education practices, concluded that teachers found the program inadequate in terms of environmental education but tried to include different methods and

techniques in the lesson. In parallel with Akalın's study, Özkan (2017), in his research on teachers' opinions, stated that teachers frequently included environmental education activities. Arslan (2023) examined pre-service preschool teachers' mental models of the concept of biological diversity and observed that pre-service teachers had misconceptions about biological diversity. In parallel to Arslan's study, Kıldan and Pektaş (2009) also found that preschool teachers need in-service training on nature. Likewise, Erten (2005) emphasized that knowledge is not effective in preschool teachers' environmental protection behaviors. In parallel to Erten, Türkoğlu (2019), in his study conducted with preschool teachers and pre-service teachers using phenomenology management, stated that while teachers and pre-service teachers were interested in environmental education, teachers were better in practice and pre-service teachers were more knowledgeable. Ikiz (2022) examined the views of preschool teachers and pre-service teachers on the place-based education approach and found that teachers and pre-service teachers considered it an effective approach in creating awareness of nature and society. Altın (2022) and Uğur (2023) showed that pre-service preschool teachers and preschool teachers had high levels of environmental education self-efficacy. Studies are revealing the role of family involvement in children's environmental behavior (e.g. Cengizoğlu, 2023; Demirci, 2023). Looking at the studies examined in terms of families, Erol and Ogelman (2021) examined the attitudes of 5-6-year-old children towards the environment and found that the environmental education program in which families participated had a positive effect on children's attitudes towards the environment. Similarly, Karahan Aydın (2019) reported that family participation in terms of environmental education practices in the preschool period is important for the development of the child.

In summary, it is seen that environmental education plays a critical role in the preschool period in terms of the development of positive attitudes towards the environment, environmentally friendly behavior, and establishing a connection with the environment. From this point of view, determining the general status of studies on environmental education in preschools in Türkiye is an important step in terms of shaping environmental education well. It is expected that studies on preschool environmental education have been increasing in recent years, and the survey model is frequently used in these studies. When the literature is examined, there are some studies evaluating the theses on environment in the field of preschool education conducted between 2000-2021 in Türkiye (Buldur & Keskin, 2022; Ogelman & Güngör, 2015; Barlas & Ogelman, 2023). While Barlas and Ogelman evaluated the theses written between 2005 and 2020 in terms of methodology, Gültekin and Buldur evaluated the theses and articles written between 2000 and 2021 in terms of year, publication type and methodology. Comparable outcomes were observed for the theses examined from 2000 to 2021 when the studies analyzing the theses on environmental education in the field of preschool education were examined. Therefore, to observe the overall trend of theses published in the future, the results of these studies were concentrated on the years after 2021. There is a growing need for research on environmental education due to the growing significance of environmental education, particularly the crucial role that early childhood education plays in promoting environmental awareness. Review articles ask what is being done and what is not being done in environmental research, which helps us see the overall trend of environmental education research and improve the effectiveness of environmental education. We can identify research gaps by regularly conducting analyses of these environmental education studies. Future research ideas can be found in the general trend of environmental education studies that are regularly conducted to assess the efficacy of environmental education, which aims to increase environmental awareness in young children. For environmental education programs, the learning-teaching process and educators, the analysis of environmental education research is therefore crucial. Furthermore, in several studies that sought to characterize the state of environmental education in the preschool sector, Buldur and Keskin (2022) discovered 33 postgraduate studies carried out over 21 years, and Gülay Ogelman and Güngör (2015) discovered six postgraduate theses over 14 years. However, in the current study, 20 postgraduate theses were found in just one year. This shows that

research on environmental education in preschool education has gained momentum recently. To show which areas of environmental education are concentrated and which areas have gaps, researchers can benefit greatly from comparing this increase with the collected study topics of the previous 20 years. As a result, rather than repeating previous research, the current study is anticipated to add to the variety of subjects and methodologies. Likewise, there is no study examining postgraduate theses focused on environmental education in 2022 and 2023. To close this gap, it is thought that there is a need to determine the general trend of theses on environmental education in the field of preschool education in 2022 and 2023. In this context, it is expected to shape environmental education and guide researchers, education experts and teachers for future studies. In this study, postgraduate theses written on environmental education in the field of preschool education between 2022 and 2023 were examined.

1.1. Purpose of the research

The aim of the study is to determine the general trend in terms of the title, subject, and method (research design/type, method, sample, sampling method, data collection tool) of the postgraduate theses on environmental education in the preschool field between 2022 and 2023 in Türkiye.

The main problem of this research is what is the general trend of the postgraduate theses on environmental education in the field of preschool education from the start of January 2022 to the end of December 2023? In this direction, answers to the following sub-questions were sought;

- What is the distribution of postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023, according to education programs?
- What is the distribution of postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023, according to the years?
- What is the distribution of the postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023, according to the universities where they were produced?
- What is the distribution of the postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023 according to their subjects?
- What is the distribution of the postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023, according to research design/type?
- What is the distribution of postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023, according to the research method?
- What is the distribution of postgraduate theses on environmental education conducted between 2022 and 2023, according to the sample group?
- What is the distribution of the postgraduate theses on environmental education in the preschool field conducted between 2022 and 2023, according to the sampling method?
- What is the distribution of postgraduate theses on environmental education between 2022 and 2023, according to data collection tools?

2. Method

2.1. Research design

The design of this study is qualitative research. Descriptive content analysis was used as the method (Çalık & Sözbilir, 2014). Descriptive content analysis is used to systematically examine and sort independent qualitative and quantitative studies of a field in depth and to identify general trends in that field. The results of the analysis are expected to guide future studies in the field (Ültay et al., 2021). The research was conducted following research and publication ethics.

2.2. Research material

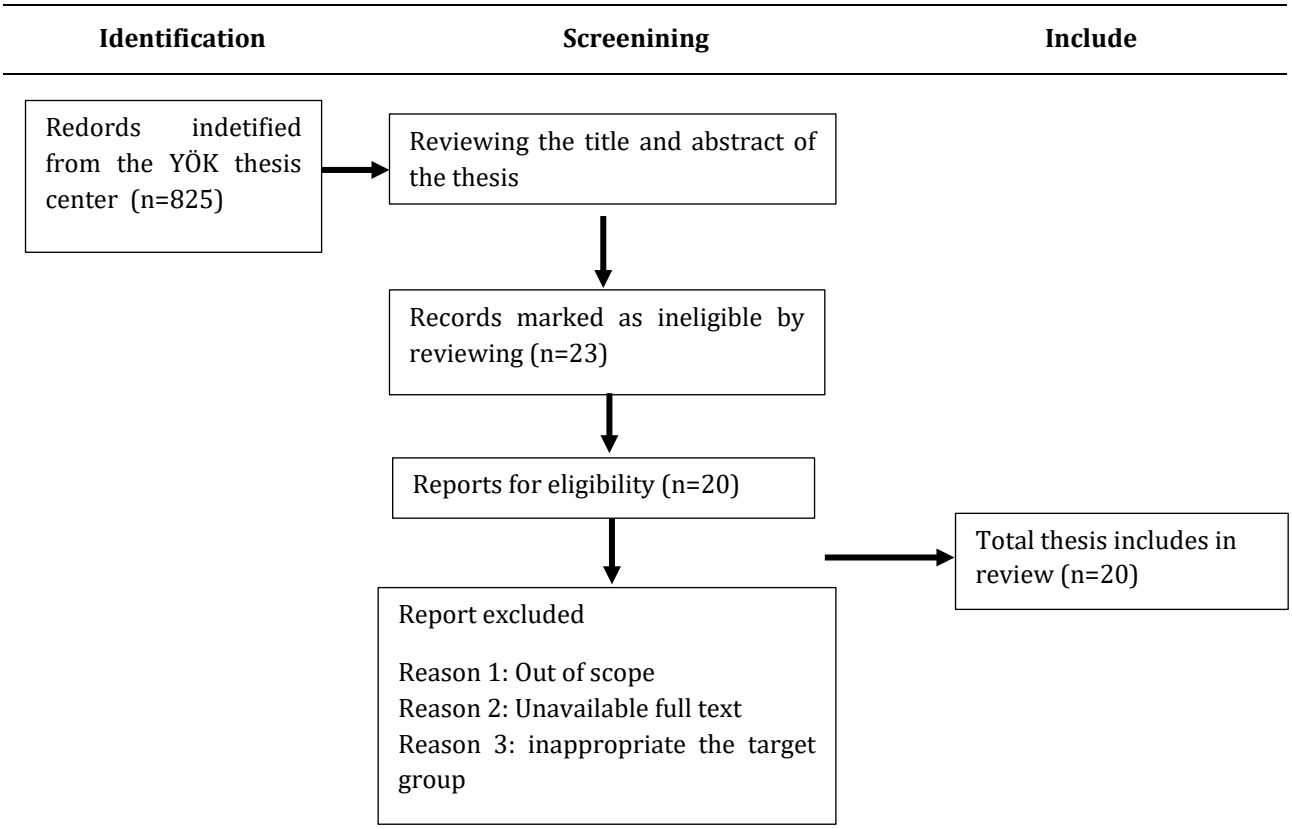
The population of the study is the postgraduate theses on the environment in the preschool field published in Türkiye in 2022 and 2023. As an extension of earlier thesis review studies on the environment in the preschool field, this study was carried out in January and February of 2024. The Council of Higher Education (YÖK) thesis search page was used to review theses with full access permission for the years after 2021. The keywords "environmental education," "preschool," "early childhood," and "child and environment" were used to search the thesis search page. We looked over the abstracts of the theses we found. Theses that were appropriate for the study's objectives and available in full text were added to the collection following the abstract review. The sample was selected by convenient sampling method since it was aimed to have access to the full text of the theses in YÖK Thesis Center database over the Internet. The sample of the study consisted of a total of 20 full-text graduate theses found in the YÖK Thesis Center database over the Internet (Appendix 1).

2.3. Data collection tool

The data collected using the transcript analysis method was reported using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline, which is recognized as a scientific standard (Figure 1). The theses included in the reporting were chosen after the titles, abstracts, and keywords of the theses were reviewed by the PRISMA guidelines. The thesis classification form (Sarı, 2011) was used as a data collection tool for analysis. The thesis classification form includes the following headings: thesis title, thesis topic, thesis research method (quantitative, qualitative, mixed), thesis sample (sample level, sample size), data collection tools, and data analysis method. In the data collection tool of this research, Sarı's thesis review form was taken into consideration, and the titles of the thesis, subject, and method (design, method, sample group, data collection tool) were discussed in the data collection form of this research.

Figure 1

PRISMA Flow Diagram



Reference: Page et al., 2021

2.4. Data analysis

The study was analyzed using descriptive statistics. Percentage (%) and frequency (f) were used to analyze the data. In accordance with Sarı's thesis review form, the title and method sections of the examined theses were moved to an Excel file. The data's validity and reliability were assessed prior to the descriptive analysis. According to the thesis review form, the theses were reassessed at various points in time regarding the suitability of the measurements because validity is the interpretation of measurements (Bademci, 2019). In order to ensure the reliability of the study, the researchers evaluated the consistency of the coding according to the thesis classification form. In other words, the consensus among the coders was examined for coding reliability. Using Miles and Huberman (2021:278) formula (Reliability = Consensus/(Consensus + Disagreement)), the coding agreement rate between the coders was 95%.

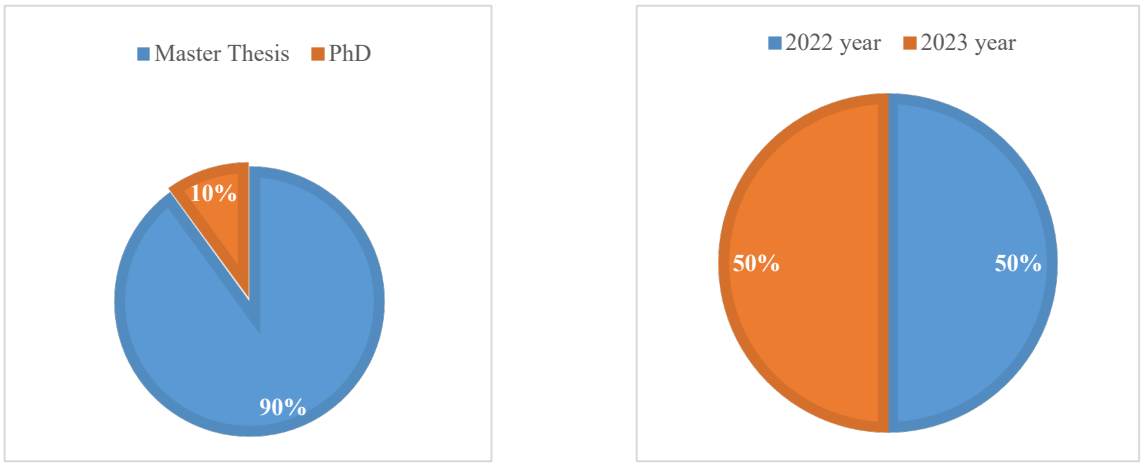
3. Results

3.1. Title of postgraduate theses

The distribution of postgraduate theses on environmental education in the field of preschool education between 2022 and 2023 according to their title is shown in Figure 2.

Figure 2

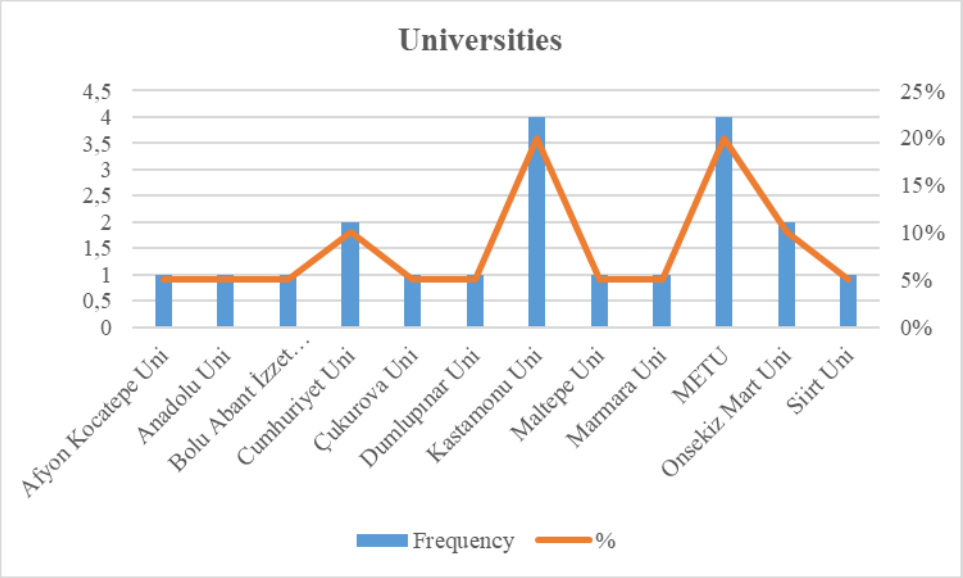
Distribution of Theses by Program Type and Year of Publication



According to Figure 2, 90% of the postgraduate theses on environmental education in the preschool field between 2022 and 2023 were completed in the master's program, while 10% belonged to the doctoral program. While 50% of these theses were published in 2022, 50% were published in 2023.

Figure 3

The University Where the Thesis Was Prepared



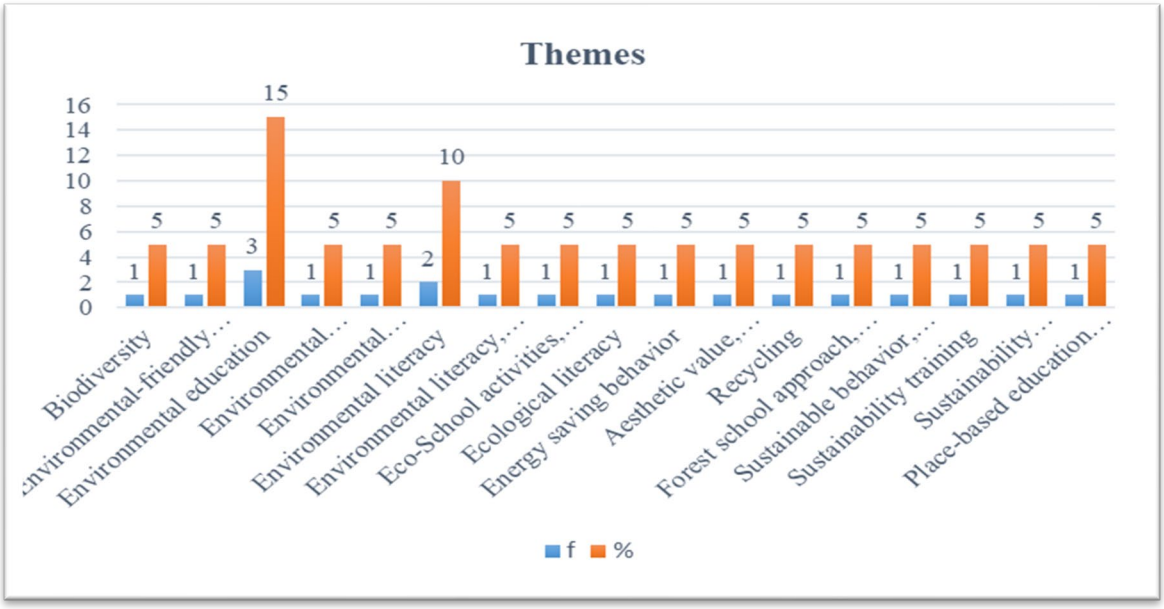
When Figure 3 is examined, 20% of the postgraduate theses on environmental education in the preschool field between 2022 and 2023 were at METU and Kastamonu University, 10% at Cumhuriyet and Onsekiz Mart Universities, while 5% were at Afyon Kocatepe, Anadolu, Çukurova, Dumlupınar, Maltepe, Marmara and Siirt Universities.

3.2. Subjects of postgraduate theses

The distribution of environmental education postgraduate theses in the field of preschool environmental education between 2022 and 2023 according to the subjects is shown in Figure 4.

Figure 4

Thesis Topics



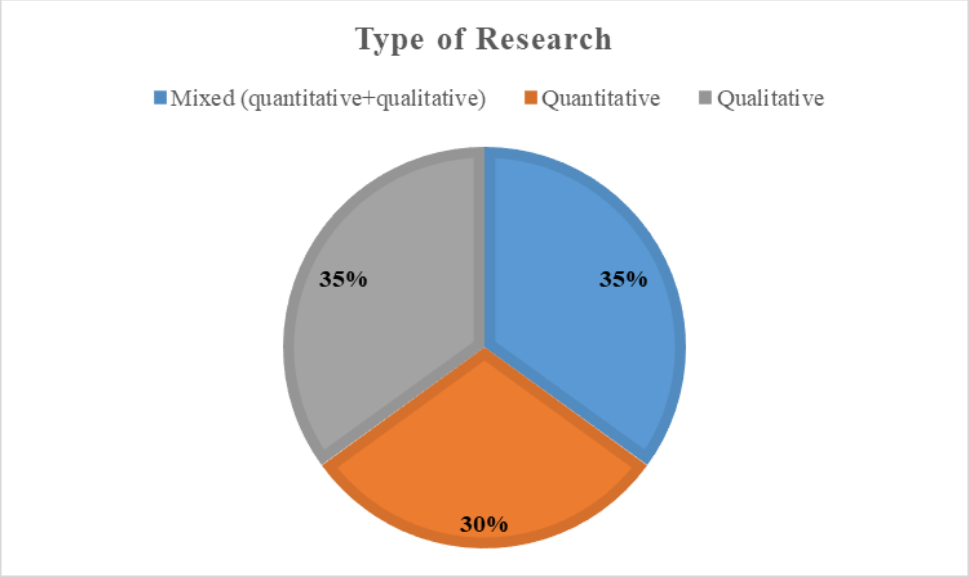
According to Figure 4, when we look at the distribution of topics in theses focused on environmental education in the field of preschool education between 2022 and 2023, environmental education (15%) was the most common topic, followed by environmental literacy (10%). Biodiversity, energy saving, etc. (5%) were the least common topics.

3.3. Research design/type in postgraduate theses

The distribution of research design/type in postgraduate theses on environmental education in the preschool field between 2022 and 2023 is shown in Figure 5.

Figure 5

Type of Research



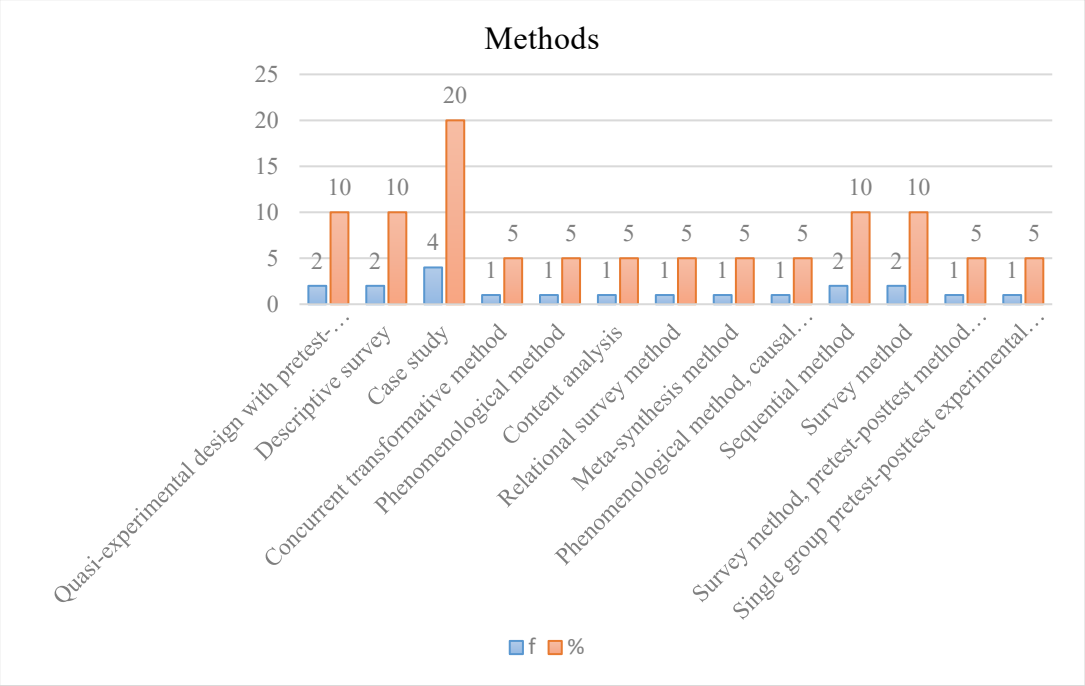
When Figure 5 is examined, it is determined that the preferred research type in theses on the environment in the field of the preschool environment between 2022 and 2023 were qualitative (35%) and mixed (quantitative + qualitative) methods (35%).

3.4. Research method used in postgraduate theses

The research methods used in the postgraduate theses on environmental education in the preschool field between 2022-2023 are shown in Figure 6.

Figure 6

Research Method



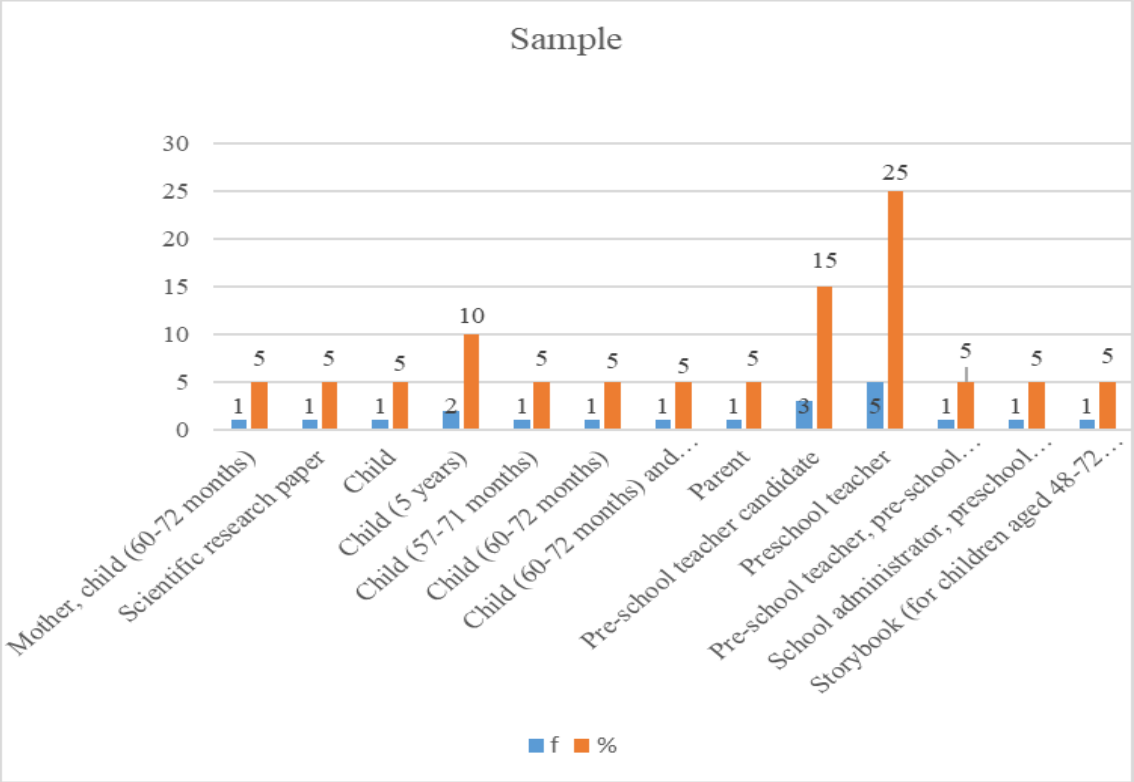
When Figure 6 is examined, it is seen that the case study method (20%) was preferred the most in theses on environmental education in the preschool field between 2022 and 2023, followed by quasi-experimental with control group (10%), descriptive survey (10%), sequential (10%) and survey (10%) methods. The least preferred methods are simultaneous transformational (5%), phenomenological (5%), content analysis (5%), relational survey (5%), meta-synthesis (5%), phenomenological (5%), without control group (5%) and action research (5%).

3.5. Sample group of postgraduate theses

The sample group in the postgraduate theses on environmental education in the preschool field between 2022-2023 is shown in Figure 7.

Figure 7

Sample Group



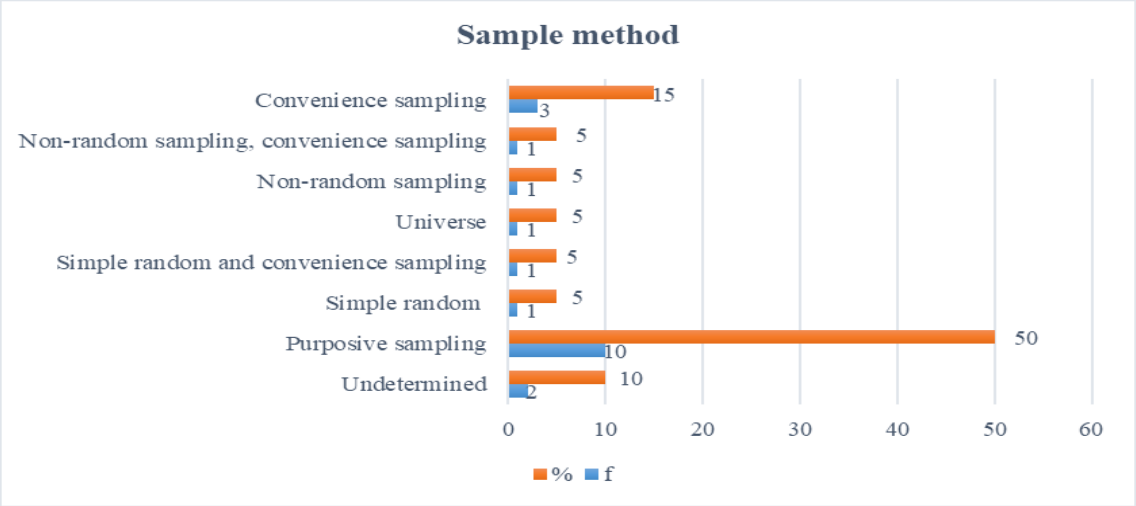
When Figure 7 is analyzed, in the theses on environmental education in the field of preschool education between 2022 and 2023, the sample group consists mostly of preschool teachers (25%) and children (25%). This is followed by pre-service teachers (15%). The last groups are mother+child, scientific article, storybook, preschool teacher candidate+teacher, school administrator+preschool teacher+parent+child (5%).

3.6. Sampling method of postgraduate theses

The sampling method used in postgraduate theses on environmental education in the preschool field between 2022 and 2023 is shown in Figure 8.

Figure 8

Sampling Method



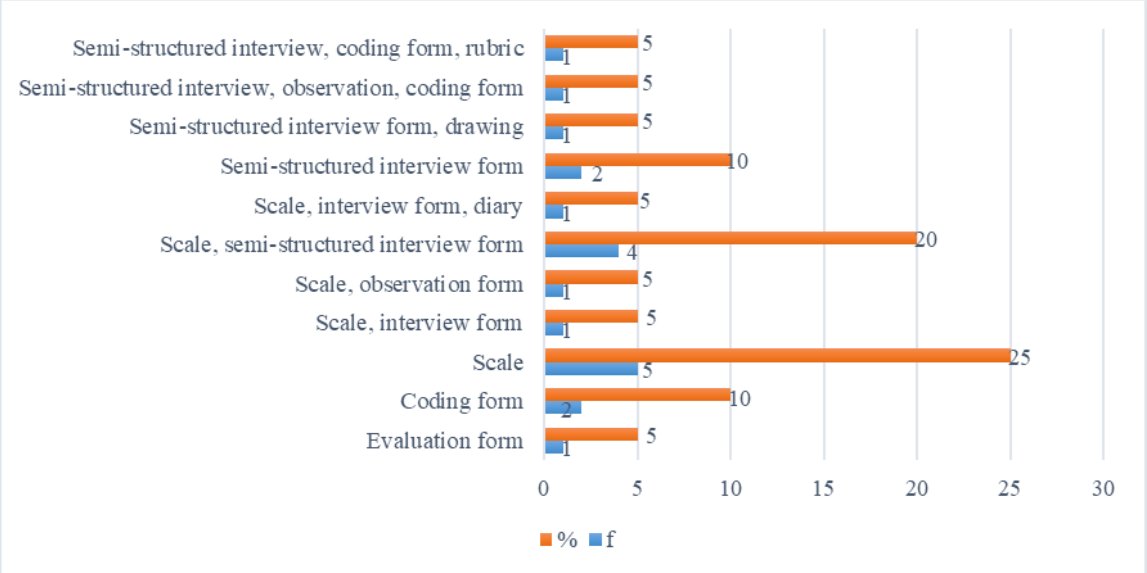
According to Figure 8, it is seen that the sampling method used in the theses on the environment in the field of preschool environment between 2022 and 2023 is mostly purposive sampling (50%). This is followed by convenience sampling (15%). The least common sampling methods are non-random + convenience sampling (5%), non-random sampling (5%), simple random + convenience sampling (5%) and simple random sampling (5%). In the graph, there is one thesis that did not use a sampling method using the population and two theses that did not specify the sampling method.

3.7. Data collection tools used in postgraduate theses

The distribution of the data collection tools used in the postgraduate theses on environmental education in the preschool field between 2022 and 2023 is shown in Figure 9.

Figure 9

Data Collection Tools



According to Figure 9, in the postgraduate theses on environmental education in the preschool field between 2022 and 2023, the scale (graded scoring) (25%) was mostly used as a data collection tool. Then, the scale and semi-structured interview form (20%) were used together. According to the figure, semi-structured interview form (10%) and coding form (10%) are the third most used tools. The last

use of one or more measurement tools was found as evaluation form (5%), scale+observation form (5%), scale+interview form+diary (5%) and semi-structured interview+observation+coding form (5%).

4. Discussion and Conclusion

This study presents a systematic analysis of postgraduate theses on environmental education in the field of preschool education in Türkiye, focusing on the period between 2022 and 2023. The analysis of 20 full-text theses identifies several noteworthy patterns that both confirm the results of earlier research and offer fresh perspectives on the developing field of early childhood environmental education studies.

First, the fact that the majority of the theses were master's level studies is consistent with earlier findings (e.g., Barlas & Ogelman, 2023; Buldur & Keskin, 2022; Karakoyun & Uzun, 2022). Barlas and Ogelman (2022) emphasized in their study that theses on environmental education in the preschool field were not published in 2005 and 2010, and that there was an increase in studies on environmental education in the following years, and that this situation was related to the achievements in the curricula for environmental education. However, what stands out is the significant increase in the number of theses within a short timeframe, which may reflect growing national and global attention to sustainability and climate education, as aligned with UNESCO's Education for Sustainable Development (ESD) framework (UNESCO, 2020). This growth suggests an encouraging momentum among early-career researchers to address environmental issues from an educational perspective.

Second, the findings indicate that research topics still largely center on general environmental education and environmental literacy, with fewer studies delving into more specific or emergent areas such as climate change, biodiversity, or ecological justice. Similarly, Karakoyun and Uzun (2022) examined the theses published in Türkiye between 2011 and 2022 on environmental education and found that "environmental education" was the most common thesis topic. This thematic concentration, although valuable, points to an opportunity for diversifying research topics to include underrepresented but increasingly urgent environmental issues (Tilbury, 1995; Davis, 2009). For instance, integrating climate anxiety in young children or exploring culturally relevant pedagogies for sustainability could provide richer, context-specific insights.

The methodological trends observed—especially the predominance of qualitative and mixed-method designs—highlight researchers' intent to gain a more nuanced understanding of preschool children's and educators' experiences. While this result partially supports Buldur and Keskin's (2022) study, it contradicts the studies of Çiftçi and Ersoy (2019). According to the preferred research method in the theses, survey and case methods were the most common, while the phenomenological method was the least common. However, there remains a relative scarcity of robust experimental studies, which are crucial for evaluating the effectiveness of interventions in environmental education. This mirror concerns raised by Çiftçi and Ersoy (2019), who noted the imbalance between descriptive and intervention-based research in the field.

Regarding sample groups, the dominant focus on preschool teachers, children, and pre-service teachers underscores the importance placed on both implementers and recipients of environmental education. Yet, the relative neglect of other stakeholders, such as families, school administrators, and community members, suggests the need to adopt a more ecological approach (Bronfenbrenner, 1977). Including these actors can offer a more holistic perspective on the environmental socialization processes of young children.

Another crucial insight from this study is the variety and combination of data collection tools, with scales and semi-structured interviews being most commonly used. Kahyaoğlu (2016) stated that questionnaires were mostly used in the scientific studies he analyzed in his study, while Çiftçi and Ersoy (2019) stated that interview forms were mostly used in the scientific studies they analyzed in their study. While these tools are effective for capturing perceptions and practices, future research could

benefit from incorporating more child-centered methods such as drawing-based techniques, storytelling, or participatory video, which have been increasingly recommended for research with young children (Clark, 2010; Harwood & Collier, 2017).

The increasing reliance on purposive and convenience sampling may raise questions about the generalizability of findings. Thus, broader and more inclusive sampling strategies could be considered in future studies to enhance representativeness and capture diverse ecological contexts across Türkiye.

In sum, this study contributes to the mapping of current research trends in preschool environmental education and serves as a baseline for identifying strengths, limitations, and future directions. It highlights a clear need for broader thematic exploration, diversification of research designs, inclusion of multiple stakeholders, and the adoption of innovative and child-centered methodologies. As environmental challenges grow in complexity, so too must the research that informs educational responses, particularly during early childhood—a critical window for shaping sustainable attitudes and behaviors.

These findings from Türkiye resonate with international trends observed in earlier and contemporary environmental education research. For example, Chawla (2002) emphasized the importance of integrating children's perspectives into sustainable development efforts, arguing that young learners bring unique insight and creativity to environmental thinking when meaningfully engaged. Similarly, Rickinson et al. (2004), in their comprehensive review of outdoor learning research, highlighted the critical role of experiential and place-based education in shaping children's environmental understanding and attitudes—a notion echoed by many of the preschool theses reviewed in this study. Moreover, Athman and Monroe (2004) demonstrated that environment-based education significantly enhances students' achievement motivation, offering evidence that such approaches not only foster environmental awareness but also support broader educational outcomes.

Taken together, these international studies support the idea that environmental education in early childhood is most impactful when it moves beyond content delivery to include active, participatory, and context-sensitive learning. While Turkish postgraduate theses have increasingly embraced these ideals through diverse methodologies, the integration of global best practices, such as community-based projects, outdoor experiential learning, and child-led inquiry, can further strengthen the scope and effectiveness of future research and practice in this field.

4.1. Recommendations

The preschool period, in which the foundation of life is shaped, is a critical period for raising environmental awareness (Özkan, 2017). The results of scientific research are important in terms of conducting environmental education more effectively in this period for environmental protection. For this reason, in future research, based on the results obtained in this study, it is thought that using research methods that have not been included so far to reach results by evaluating the environmental education, stakeholders, and educational materials from different angles for more effective education, taking into account the ecological systems theory (Bronfrenbrenner, 1977), considering other stakeholders related to the preschool child as a research group, and focusing on the diversity of data collection tools will provide a wealth of research on environmental education in the preschool field

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Plagiarism Statement: This article has been scanned by iThenticate.

Appendix 1 List of Theses Analyzed in the Study

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Research Article

A Systematic Review on AI Technologies in English as a Foreign Language Education

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Abstract: This systematic review reports an analysis of research articles on AI technologies in English as a foreign language education. The review specifically addresses the limitations reported in the studies conducted between 2020 and 2024 and shows the benefits of AI technologies identified in those studies. Hence, the study aims to provide an understanding of the scope of existing research and, depending on the limitations identified, give insights into further research. The research articles were screened and analyzed using qualitative methods based on the predetermined inclusion and exclusion criteria. The findings indicated that AI technologies may positively affect language development, cultural understanding, learner engagement, learning support, and critical thinking. Nonetheless, the limitations identified - categorized as instructional, methodological, and technological - should be taken into consideration for a more robust investigation.

Keywords: Artificial Intelligence, Review, EFL, Education, Technology

1. Introduction

As a global lingua franca, English has been widely used in international economic, cultural, and digital contexts (Marlina & Xu, 2018), and this has led to a change in the definition of native speakers by redefining English speakers. Hence, the traditional focus on native-speaker accuracy has become less significant. Instead, the ability to negotiate meaning and communicate effectively across different countries and nations has been crucial. Hence, practice and research of English language teaching (ELT) have gained importance by concentrating on other demands in ELT, such as English as a second language, a foreign language, for specific purposes, and academic purposes (Kumar, 2024).

Despite its gained importance, English language education suffers from a lack of resources, and uneven instructional quality or instruction cannot be adapted to students' individual needs or speed depending on the context where English is taught (Cuong, 2021). Modern and technology-driven solutions might assist in handling these challenges. Technological improvements have brought diverse digital tools into ELT, which have significantly affected it by fostering learning, increasing students' engagement, and enabling quality education (Kumar, 2024).

Recently, artificial intelligence (AI) advancements have offered new opportunities for renovating English language learning. To illustrate, Tolstykh and Oshchepkova (2024) explain that AI tools have the potential to act as helpful learning partners for language learners by answering their questions, giving feedback on grammar or vocabulary input, and translating a text into the needed language in a motivating atmosphere. Dennis (2024) expounds that AI enhances language learning by employing the underpinning ideas of the interactionist approach, which is simply based on the idea that language is best learned through meaningful communication and interaction. It undertakes the role of a virtual tutor providing personalized support to language learners (Dennis, 2024). Likewise, Fountoulakis (2024) mentions the effectiveness of AI in creating opportunities for personalized learning experiences and authentic conversation practices. Additionally, Gu (2024) explores the positive impacts of AI tools on language learning. Specifically, the study suggests that AI improves language skills by enabling students to learn more effectively, focus on tasks better, and manage their attention more effectively during the tasks; additionally, the students can process and use new information better, which indicates positive effects of the AI use on improved working memory abilities.

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AI has progressed a lot by greatly impacting the educational realm. In language learning and teaching, its use has been profoundly proposed in different studies. The studies have noted its benefits for language learners by also criticizing its points to improve and suggesting how to be aware of its potential drawbacks for the students and the educators. Recently, several research studies have investigated the use of AI technologies in language learning settings by focusing on different periods for the investigation of the studies and by focusing on different aspects of AI use in language learning. One of those reviews is Sharadgah and Sa'di (2022), which explained the practices in the field at the time, encapsulating the years of research (2015-2021) and understanding the difficulties by employing qualitative research methods on 200 articles, which were later decreased to 64 articles. The study was based on English language teaching (ELT) and indicated that AI offered positive outcomes for using language abilities, evaluation, recognition, translation, feelings, thoughts, and fulfillment. The review showed that mixed-methods studies were more common; the education level of the most sampled was higher, and most students were involved in the studies as participants. In another review article, Xing (2023) discusses the use of ChatGPT for listening and a Convolutional Neural Network [CNN] model, which is used for speech and image recognition. The researcher explains that CNN models are effective for giving quick feedback on pronouncing words and adjusting intonation, together with other aspects of verbal interaction. The review suggests combining the features of ChatGPT and the CNN model, thereby joining speech recognition competencies with ChatGPT's communication interface and enabling people to be involved in real-like conversations and obtain input on pronunciation and understanding.

Cromptoni et al. (2023) also examined studies on AI technologies in language education. This study involved searching for the geographical places where AI studies are being conducted, the ages of participants, the ways of using AI in ELT or English language learning (ELL), and the difficulties of using AI in ELT/ ELL. The study used PRISMA techniques. Only peer-reviewed journals were included. The articles were from 2014 to 2023. The search yielded 369 articles for potential analysis in the review. After implementing the inclusion and exclusion criteria, 43 articles were examined using a grounded approach.

Similarly, Shafarini et al. (2023) explored the effects of AI on English language teaching in literature studies. The research was based on qualitative data analysis. Sakach (2022) wrote a review of an AI application on mobile phones and its integration into foreign language learning. The paper showed the positive influence of the app, especially on word stress and pronunciation. In a different review study, AlTwijri and Alghizzi (2024) examined the studies conducted to investigate how useful AI technologies are in higher education in developing affective factors such as motivation, engagement, attitudes, and anxiety. The study investigated research between 2017 and 2023. The review concludes that AI technologies are promising in foreign language education; they enhance motivation, engagement, and attitudes.

1.1. Theoretical framework

This review is based on the theoretical framework of Intelligent Computer-Assisted Language Learning (ICALL), which enhances the language learning process using resources that involve the wide use of sophisticated practices (Ward, 2017). Being based on Natural Language Processing (NLP), ICALL brings new possibilities to education, enabling the interaction between humans and machines and developing learning, cooperation, and commitment (Shardlow et al., 2022). It is based on AI-driven systems, and these systems positively impact language learning by giving authentic interaction opportunities to students (Ji et al., 2023) and offering adaptive feedback based on students' needs (Kamruzzaman et al., 2023). By personalizing the difficult tasks and assessments, AI-driven technologies bring tailored education and more effective assessment of individual progress (Alqahtania et al., 2023).

Starting with the use of computers in the 1960s, AI has a long history in language learning, making language learning more individualized, collaborative, and effective (Sumakul et al., 2022). Despite its

benefits, research has also shown some setbacks in using AI-driven technologies. These include ethical problems, diminished human-student interaction (Zhang & Mao, 2023), and data privacy problems, arising from the potential sharing of personal information with third parties (Adamopoulou & Moussiades, 2020). Given these challenges, it is evident that AI does not yield consistently positive results for all learners. To make the most of this technology, learners should take an active role in their education instead of relying on it passively. Wang et al. (2023) emphasize that the human-to-machine interaction needs to be tailored to the learner. AI technologies need to be approached critically and realistically because the assumption that AI technologies ensure effective education may be mistaken. The benefits depend on learning strategies, views and expectations (Wang et al., 2023). For optimal benefits of AI in language learning, instructional methods and activities should be designed and implemented carefully.

1.2. Significance and purpose of the study

AI use in foreign language education has been researched extensively, but the fast development of this technology means the findings of many earlier studies may now be outdated. As a result, an updated review is significant to assess the present effectiveness of AI in language learning contexts and to provide practitioners with an understanding of its merits and weaknesses. The present review is based on the studies conducted between 2020 and 2024 to explore the recent developments that previous reviews may have discounted. Therefore, the aim is to inform educators, researchers, and educational leaders about emerging AI features that can meet the pedagogical needs in the classroom, develop curricula, and open new areas for future research. Based on this purpose, the present review addresses the following research questions:

- What kinds of AI-related benefits were explored in English language education studies between 2020 and 2024?
- What kinds of limitations did the studies of English language education between 2020 and 2024 account for?

The following section details the methodology adopted to explore the research questions above.

2. Methodology

The Preferred Reporting Items for Systematic and Meta-Analyses (PRISMA) guidelines were adopted in the present review to ensure a thorough, transparent, and replicable review process (Page et al., 2021). Based on the research purposes of the present study, inclusion and exclusion criteria were determined when selecting the studies to be analyzed in this review. This section explains the methods employed for the present review's data collection and analysis procedures.

2.1. Eligibility criteria

Depending on the research purposes of the present study, studies to be involved in the present review were determined. In August 2024, the databases EBSCOhost and JSTOR were searched to identify the studies to be included in the current review. These two databases, which have large and quality coverage of peer-reviewed literature in education, were deliberately selected for the current review. EBSCOhost provides access to Education Source, ERIC, and Academic Search Premier, which are other educational databases that present studies on AI in education. JSTOR provides journals in the humanities and social sciences related to language education.

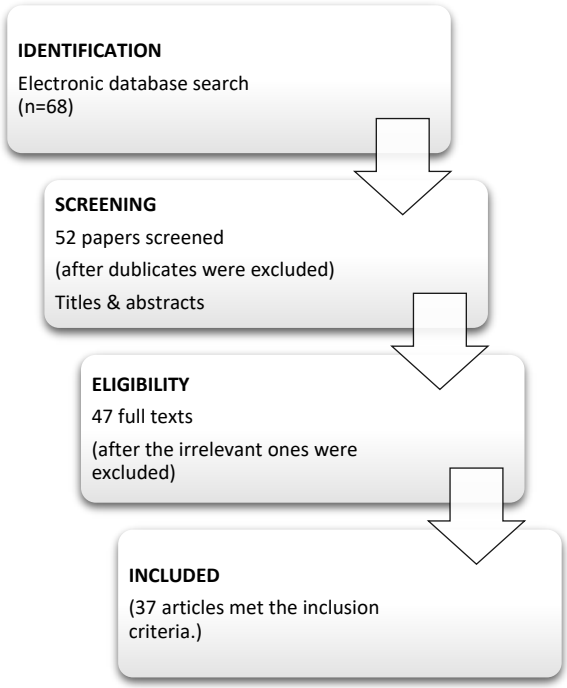
The adopted search strategy involved constructing the search terms ‘Artificial Intelligence’ or ‘AI’ and ‘Language Learning’ or ‘English Learning’. These keywords were logged into the databases to retrieve studies. In the search, these keywords were also tried with their alternative versions, for example, in lowercase. The types of AI interventions were not limited to a specific tool or application. Instead, all types were considered, such as AI partners, speech recognition, and mobile applications, in the analysis.

The inclusion criteria encapsulated the search of only peer-reviewed journals and PDF full-text research articles. Also, only English articles were included, and the date range for publication was determined from 2020 to 2024, thereby indicating the up-to-date studies in the field of research. Consequently, the studies were excluded if they were not listed once the keywords in the inclusion criteria were not met, were not published as research articles in peer-reviewed journals, were not written in English, or were not published within the predetermined publication dates in the present review.

In the selection process, each record was screened and retrieved from the database using library automation software, enabling a quick search to locate studies under scrutiny. As a result of the identification of the databases, 68 records were identified from the databases. However, 16 of 68 studies were removed from screening since they were duplicates. Also, 5 studies were marked as ineligible and were not involved in the screening process since they were not accessible. Those studies were indexed in the selected databases in the present review, but the full texts were not available, which might be due to the subscription limitations of the journals on the availability of the full texts. As a result, the titles, keywords, and abstracts of 47 studies were screened. At this stage, 10 records were excluded because they were review articles, not research articles. Eventually, 37 studies met the study's eligibility criteria and were included in the study for the detailed analysis, as shown in the figure below.

Figure 1

The Flow Diagram for the Identification of Studies Via Databases



2.2. Data collection

After the eligible research records were selected, they were downloaded and stored for further analysis. To collect data from the records, a form with data points such as the study design, participants, AI tools used, results, and limitations was prepared to fill out for each record in Excel. Each record was examined in detail, and the researcher, as the reviewer, completed the form with the required information by labeling each study with the necessary information. Later, the completed forms were shared with a second reviewer. The second reviewer holds a PhD in ELT and possesses subject expertise relevant to the present study. She participated in the present study based on her prior experience in qualitative coding. For consistency and effective coding outcomes, several coding meetings were conducted with the second reviewer to ensure consistency and develop coding principles (Hoda, 2024). Therefore, a meeting was held with the second reviewer, and the labels and details on the sheet prepared were

discussed. Subsequently, the reviewer was asked to be involved in verifying data accuracy by checking the completed forms and identifying the missing points, if any, in the forms. To ensure intercoder agreement, Roller and Lavrakas (2015) explain that quantitative agreement methods may simplify the data and decrease validity, so this is not necessarily required. Instead, agreement could be reached through discussions and consensus in the meetings with the coders. As a result, coder agreement in the present study was reached through mutual consensus rather than statistical measures.

2.3. Data analysis

The present research involved qualitatively analyzing the extracted data by performing content analysis. An inductive approach was adopted during the analysis, which required building themes and categories from the data instead of the existing frameworks. For systematic analysis, qualitative data analysis software NVivo was employed during the analysis process. Using qualitative data analysis software such as NVivo helps to organize and manage a large amount of data effectively and provides quick retrieval of the data (Silverman, 2010). In this study, the dataset was first imported into NVivo, where the reviewers examined it. Using the software, the reviewers identified the codes and developed themes from the data. The software facilitated the process by generating organized word frequency reports and coding summaries, which enhanced the efficiency and clarity of analysis.

3. Findings

The purpose of the present review is to present the main themes related to AI use in English as a Foreign Language between 2020 and 2024. This section presents the study's key findings, providing a detailed explanation of the themes and codes in alignment with the research purpose. The findings are presented under the general themes of the positive effects of AI technologies and the limitations of using AI technology.

3.1. The general features of the studies

This section presents the general features that studies involve. Specifically, the section displays the education levels, participants, and study contexts based on geographical scopes and the research methods adopted in this study to better understand the studies reviewed in the current paper.

3.1.1. Research methods of the studies

The studies that were analyzed in the present research had various designs for investigation and analysis. Detailed analysis indicated that most of the studies adopted a quasi-experimental research design, which involved investigating a particular type of AI technology with a structured experiment, with a comparison to a control group. Accordingly, 57,14% of the studies were reported as having experimental research design. 28,57 % were based on qualitative research design. 14,29% of the studies were reported as case studies.

The data collection processes of these studies encapsulated qualitative and quantitative methods. Various methods such as semi-structured interviews, surveys, self-reports, questionnaires, class observations, voice recordings, dialogue, and information memory of chatbots were employed to collect data in the studies. Likewise, the data analysis methods involved qualitative and quantitative methods. The studies indicated that qualitative data were analyzed using thematic analysis methods and open coding methods. The data collected through quantitative methods were analyzed utilizing statistical tests such as ANCOVA, paired samples t-test, descriptive statistics, and non-parametric tests such as Kruskal-Wallis and Wilcoxon Signed Rank test.

3.1.2. Context, participant profiles, and geographical scope

When the contexts where the studies were conducted were examined, the findings indicated that most of the studies were conducted at the university level (62,5 %), which showed that the studies were

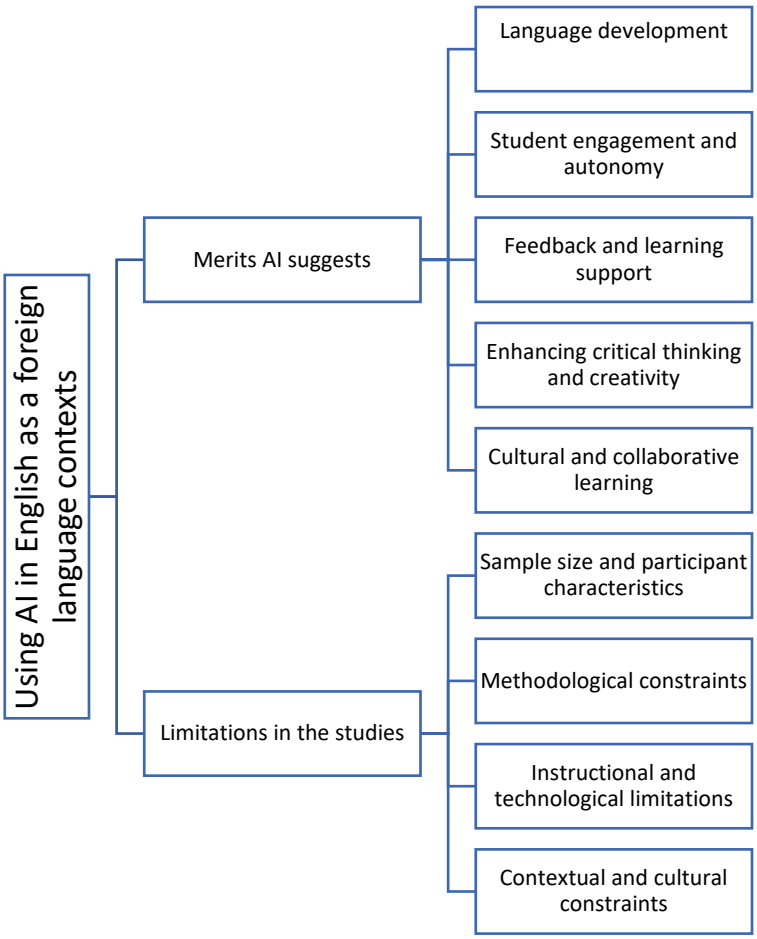
performed at higher education institutions such as universities, colleges, undergraduate, and vocational schools. The next education level at which the studies were done was high schools (18,75 %). Few studies were conducted at primary schools (grade 3 and grade 5) (6,25 %) and secondary schools (6,25 %), while 6,25 % did not indicate a particular education level to introduce the participants. Rather, the participants were introduced as EFL test takers, for example.

When the participant profiles were examined, it was found that most of the studies (68,75 %) investigated the EFL learners' perceptions, attitudes, or practices of AI in their language learning processes. Despite the low number of studies, 31,5 % of the studies under review in the present paper researched the use of AI in language contexts from language teachers' perspectives.

The geographical scopes of the studies were various. The specified countries in the studies included Thailand, Ukraine, South Korea, Saudi Arabia, the Philippines, and China. Most of the studies were carried out in China. Thus, the studies entail a diverse geographical representation reflecting a cultural and educational context ranging from Eastern Europe, the Middle East, and Asia.

Figure 2

The Positive Effects of AI Technologies and the Constraints in the Studies



3.2. The positive effects of AI technologies on language learning

The analysis of the studies indicates that the use of AI in EFL contexts positively influences language development, student engagement and autonomy, critical thinking and autonomy, language development, feedback and learning support, and cultural and collaborative learning, as seen in Figure 2. In this part, the details regarding the findings are presented thoroughly.

3.2.1. Language development

The studies in the present review showed that different AI technologies effectively improve students' language development. The potential of AI technologies can be beneficial for different language skills such as writing (Praphan & Praphan, 2023), vocabulary (Hsu et al., 2023), grammar (Xiao & Zhi, 2023), listening (Betaubun et al., 2023; Xing, 2023), and speaking. The analysis of the studies under review revealed that using AI technologies positively affected students' language achievement by positively impacting linguistic variety, correctness, and accuracy (Fathi et al., 2024).

The development of speaking proficiency thanks to AI technologies is the most highlighted effect in the studies examined in the current paper. When the studies were examined closely, it was found that, for example, students' interaction with an AI bot such as ChatGPT improved their speaking skills by decreasing students' speaking anxiety and increasing their confidence to speak (Park, 2022). In another study, the students were engaged in interaction in a virtual reality setting; hence, their identities were not apparent, which helped them to be more active in speaking (Mabuan, 2024). Regarding the positive impact of AI on speaking skills, the studies mention that AI tools provide quick feedback on pronunciation and intonation as well as other aspects of communication (Khalifia & Ginting, 2024; Xing, 2023). For example, Chen (2024) showed that mobile-assisted instruction helped learners effectively control their speaking speed, intonation, and the use of fillers in speech. Fathi et al. (2024) indicated that using such tools enabled students to speak without restrictions and increase their fluency. With the indulgent environment, they facilitate an anxiety-free atmosphere by creating exciting classes that enhance students' speaking (Yeh, 2024).

3.2.2. Student engagement and autonomy

In the studies, the positive effects of AI tools on the encouragement of students for active participation, motivation, and independent learning in EFL settings have been given. Specifically, the studies indicate that AI tools present individualized and autonomous learning prospects (Horn, 2024; Sütçü & Sütçü, 2023). AI-supported learning has the potential to improve student engagement. For instance, learners can improve their vocabulary acquisition by utilizing self-regulated learning strategies (Ivanytska et al., 2024). Also, it can enhance language learning by tailoring the instruction according to the learners' requirements and capabilities (Yang, 2024).

3.2.3. Feedback and learning support

One of the themes from the data is that AI tools provide students with feedback and learning support. The studies under review feature the effectiveness of these technologies in providing immediate feedback (Xiao & Zhi, 2023) by revising the texts (Shen et al., 2023) or giving content-related suggestions. Using AI technologies, learners can receive personalized feedback, for example, on their speaking performance (Chen, 2024).

3.2.4. Enhancing critical thinking and creativity

Utilizing AI tools, the findings indicate that students can develop their critical thinking skills by analyzing the information produced by AI (Abdalgane & Othman, 2023; Xiao & Zhi, 2023). Xiao and Zhi (2023) indicated that when modifying the prompts, training the bot, verifying, and accepting the outputs, students use critical thinking skills, which enhances students' language proficiency. The researchers also mention the positive effect of ChatGPT on generating ideas. Xiao and Zhi (2023) explain that as students in their study got help from ChatGPT for revising the texts, content-related suggestions, and supporting ideas for their arguments, ChatGPT holds the place of a tutor.

3.2.5. Cultural and collaborative learning

The studies under examination highlighted the effect of AI tools on cultural awareness and collaboration among learners. Using technology, including culturally responsive instruction, could enhance learning

outcomes and support the development of cross-cultural communication (Larasati & Ginting, 2024; Mageira et al., 2022; Zhang, 2022). Besides, Horn (2024) underscores that AI-supported instruction, for instance, with ChatGPT, can provide an active classroom dynamic as they can work in groups and individually. Hence, the studies show that AI technologies impact cultural understanding (Zhang, 2022) and collaboration among learners (Lee et al., 2022).

3.3. Limitations of the AI technologies in the studies investigated

Limitations found in the AI studies were organized under five titles: sample size and participant characteristics, methodological constraints, technological limitations, and contextual and cultural constraints (shown in Figure 2).

3.3.1. Sample size and participant characteristics

The limitations under this title were mainly based on a constraint of the studies, as the number of participants (e.g., Chen, 2024; Jia et al., 2022; Jin, 2019; Qiao & Zhao, 2023; Zhang et al., 2024). In the same vein, another limitation of the studies was noted, as the participants were from a single institution, which also limited the study in terms of representing a larger community (Fathi et al, 2024). In some of the studies, the researchers asserted that there was limited diversity in the participants' backgrounds, ages, motivations, and academic contexts (Liu et al., 2023; Liu et al., 2024). Also, some studies lacked the representation of diversity in the sample. For instance, Zheng et al. (2024) explain that teachers' perspectives were not investigated in their study; only the students' perspectives were examined.

3.3.2. Methodological constraints

The studies suffered from a short duration of intervention and longitudinal studies, which were carried out to reveal the effectiveness of AI technologies (Mabuan, 2024). Also, in some of the studies, the intervention was context-specific. For example, only a single mobile phone app was investigated, or only a particular university was involved in the study (Li & Chan, 2024). Additionally, some studies encapsulated an investigation of only one single skill, such as writing or speaking, which was noted as a limitation of the studies (Liu et al., 2023). Other studies mentioned the limited consideration of additional variables such as self-efficacy, learner motivation, or technology acceptance (Zheng et al., 2024). In addition, some studies had only an experimental group and lacked a control group for comparison (Shen et al., 2023). Therefore, the suggested future studies involve study designs that would have a control group, and the data could be gathered in various ways rather than relying on self-reported data, which may lead to bias.

3.3.3. Instructional and technological limitations

Limited timeframe and instructional approaches (Qiao & Zhao, 2023) were mentioned as the points that need to be improved in future studies. Also, the studies indicated a need for more user-friendly technology interfaces and training for teachers and students (Yeh, 2024). In the same vein, it could also be added that due to the evolving nature of technology, further studies are necessary to be done for updated information (Horn, 2024).

3.3.4. Contextual and cultural constraints

Some of the limitations mentioned in the studies were grouped under the title of contextual and cultural constraints. One of the findings here shows that because the studies were carried out in one cultural and educational setting, the results cannot be generalized (Zhi & Wang, 2024). Due to a localized study environment, the results had limited generalizability (Zhang et al., 2024). The need for the expansion of research to different education levels is noted in the studies. Another limitation was the researcher serving as the instructor. This negatively influenced objectivity, so Horn (2024) suggests the positive effect of conducting the research in a different context where the researcher is not the teacher of the class.

4. Discussion

The analysis of the studies in this paper yielded profound insights into the benefits and limitations associated with integrating AI into EFL settings. This section discusses the findings in detail based on the relevant literature.

Depending on the investigation of the impact of AI on language development, an improvement in writing, speaking, and listening skills, together with grammatical and lexical skills, has been found as a result of the use of AI technologies in learning settings. Of the skills noted in the studies under review, the most highlighted one is speaking. Regarding the enhancement of speaking, pronunciation studies are foremost. Related to the positive effect on speaking, the literature shows that AI seems to be a conversation partner and a language coach. (Cromptoni et al., 2023). Similarly, Zhang et al. (2024) explain that using Lora, a bot, positively influenced learners' foreign language enjoyment and willingness to communicate. Besides, students' foreign language anxiety declined remarkably. In a different study, Qiao and Zhao (2023) state that AI-based instruction effectively augments students' speaking skills and is good for their self-regulatory processes by helping them adjust their learning processes and set goals more effectively. AI-based instruction contributed to students' control in their learning processes and helped them cultivate metacognitive strategies required for speaking skills.

Since technology is convenient and accessible, learners can receive personalized training and feedback for speaking in an anxiety-free atmosphere at any time (Chen, 2024). Learners' speaking skills improve when the learners are engaged in interaction with an AI chatbot (Park, 2022), and learners can learn how to control their speaking speed, intonation, and the use of fillers (in speech) effectively (Chen, 2024). This is because of low-level anxiety, increased interest, and self-confidence while speaking because of chatting with an AI bot (Park, 2022). Fathi et al. (2024) also explain the chatbot's positive impact on developing students' speaking skills and the students' positive attitudes and thoughts about AI-supported speaking learning. Similarly, Chen et al. (2022) revealed the participants' positive attitudes toward using the robot because it increased their motivation and engagement. In addition, the study indicated that the research positively affected the students' speaking skills, fluency, and vocabulary knowledge. When all the positive influences of AI-supported learning are considered, it might be assumed that technology-supported learning presents opportunities for improving speaking in a foreign language. Therefore, it is necessary to integrate AI-based activities in speaking classes to develop learners' speaking skills and to increase students' engagement with their peers and AI through speaking activities (Qiao & Zhao, 2023). Hence, students can receive input from their peers and use AI technology since AI technology can contribute to the educational realm by creating more meaningful, engaging, and communicative learning settings (Almira, 2023).

Another significant finding emerging from this study is that AI-enhanced language learning fosters greater collaboration among learners. To elucidate, Horn (2024) states that AI was effective in giving real-time input and assistance to large groups of students. Students were motivated due to the innovation and effectiveness of ChatGPT. The researcher stated that students could work individually and in groups, and ChatGPT enabled an active classroom dynamic. It also helps foster cultural understanding by engaging learners with authentic cross-cultural scenarios (Zhang, 2022). In a separate study, Mabuan (2024) also highlights that ChatGPT may promote cultural awareness. He (2024) exemplifies that on AI-supported platforms, such as English cultural exchange platforms, learners can engage in cross-cultural interactions, which is effective in enhancing language learning and promoting cultural understanding. Thus, language learning can be supported with authentic cultural exposure and linguistic input. Technology eases the transfer of learning to the outside of the classroom by creating more learning opportunities (Lin & Mubarok, 2021).

The analysis of the studies indicated that integrating AI into the learning environment positively influences student engagement and autonomy, as also revealed by AlTwijri and Alghizzi (2024).

Similarly, Ivanytska et al. (2024) explored the positive influence of social media and AI-supported apps on vocabulary learning, engagement of students, and their language proficiency. Therefore, by considering the crucial importance of technology in the education field, it seems that it is essential to form an educational pedagogy according to the advancements in technology. Likewise, Wei (2023) supports the positive effect of AI-based instruction on learners' engagement by also having a positive impact on motivation. Despite the positive aspects of AI, Ivanytska et al. (2024) explain that it is necessary to have an attitude towards the use of AI-driven applications and social media platforms in language education, and accordingly, the potential advantages of such technologies should be balanced with taking required precautions not to lose the quality and integrity of the learning and teaching process.

A different finding in the present study showed that although the research contexts are diverse with respect to education level and geographical scopes, research at the higher education level is more common than at other levels, such as elementary and secondary school, in the studies examined. Undoubtedly, AI incorporation into all education levels is pervasive, and the literature suggests that young learners' interaction with AI-based bots can boost their cognitive abilities, affective engagement, and learning skills (Kewalramani et al., 2021). Thus, it might be concluded that there is a tendency to conduct research with adult learners. Future research based on investigations with younger age groups might give insights into how to integrate these technologies into the lower age groups.

As evidenced in the current review, the studies that were examined exhibited limitations, primarily classed as instructional, methodological, and technological. The analysis indicated that the studies lacked a long timeframe of training for the participants in a study (Horn, 2024) or a different study; without highlighting the insufficiency of the training, the researchers explain the lack of complete training to use a particular technology (Xiao & Zhi, 2023). Also, the research shows that some limitations might emerge because the control group, for example, received ineffective or uncontrolled instruction in the research design compared to the experimental group receiving AI-supported instruction. In such cases, Qiao and Zhao (2023) explain that the result could be different from the present with a diverse technique to enhance a skill such as speaking. Therefore, when the instructional constraints are considered, the findings here suggest the necessity for both comprehensive training (Zhang et al., 2024) and methodologically sound research design, which could enable us to draw more reliable conclusions regarding the effectiveness of AI technologies in education.

When the methodological constraints are analyzed closely, they show that the research design adopted in the studies under review lacked longitudinal research, which could have revealed the effects more robustly. Such studies present a more thorough and precise depiction of the developing relationship between AI technologies and learners (Polyportis, 2024). This finding implies the need for research to uncover technology's long-term effects. Additionally, the limitation of the study was the absence of a control group for comparison. A study designed with a control group would leverage the reliability of the relationship between the two constructs to be measured (Shen et al., 2023). A different constraint that should be considered in the next studies is the reliance on self-reported data instead of more objective data collection methods, yielding more effective results by avoiding bias (Li, & Chan, 2024; Zhang et al., 2024). Using self-reported data can bring about certain disadvantages, such as the negative impact of wording and format of questions on the accuracy, systematic tendencies to respond unrelatedly to the content, and biased responses, such as extreme responding, answering depending on the social desirability, as explained in McDonald (2008). Despite the disadvantages of self-reported data, their advantages, such as being practical and efficient, easy to administer, and providing direct insight into unique personal information, make them more commonly used in research. Therefore, strengthening the methodological weaknesses of research with self-reported data and using more behavioral and multiple methods could be effective in enriching the research data and making it more

reliable and valid (McDonalds, 2008). Another constraint specified in the findings of this research is technological constraints such as temporal factors of technology, such as the novelty effect of technology and its implication, and the evolving nature of technology (Horn, 2024) could be examined better by understanding how the novelty effect of AI could be pursued by the learners and in what ways the educators and policymakers improve it in education.

The research highlights the positive impact of culturally sensitive and AI-supported technologies on skills such as critical thinking and creativity (Larasati & Ginting, 2024). Related to creativity, Zhang et al. (2024) also mentioned that one of the positive effects of AI-based assistants is "they can create a translanguaging space for students," which enables students to think more productively and critically and speak without restrictions (p. 12). Thus, AI-based technologies foster more prolific and unlimited expression of critical thinking. Furthermore, Chen (2024) reported the participants' positive feedback on the effect of novelty on their interest, which implies that such technologies enhance the connection between modern learning environments and student engagement. On the other hand, Horn (2024) highlights that it could be good to conduct the study in different contexts where the researcher is not the teacher of the class. As an explanation for this, the researcher mentions the students' inhibition in expressing their opinions openly toward their teachers/researchers. When all the findings here are pondered, it is evident that the potential of AI for learners cannot be disregarded. It is effective in the betterment of the language learning process. Culturally sensitive and creative AI tools can improve learning; however, there is a need for meticulously designed and controlled research settings to confirm the findings.

5. Conclusion

This review paper aims to describe recent research on the use of AI in EFL contexts. For this purpose, a systematic analysis was carried out, and the findings revealed the general features of the studies, the gains of using AI in language learning settings, and the limitations of the studies. The present paper indicates the existing research and key methods adopted to guide future research on AI in language learning settings. Also, the review highlights the limitations in the studies, which may help researchers avoid the same limitations in the next studies, displaying the research that needs to be improved.

This paper indicates that AI use in language learning settings has various advantages, from developing language skills to enhancing cultural and collaborative learning. For educators, these insights suggest incorporating AI tools in a decisively and instructionally grounded way so that they can meet learning objectives and respond to learners' needs. However, the limitations based on sample size and methodological and instructional constraints underscore the need for flexible and tailored approaches, which highlights that educators should employ AI tools within their specific contexts and adapt their practices accordingly. For policymakers, the findings suggest investing in infrastructure, supporting AI training, and providing access to AI-supported learning opportunities in different educational settings, and supporting longitudinal studies with varying technologies in diverse contexts.

5.1. Limitations and suggestions for future research

Despite the implications that could be derived from the present review, it suffers from certain limitations that need to be considered in future studies. For instance, the results in this paper were based on the findings from the studies conducted in the period 2020-2024 (August), focusing only on the language learning setting. However, as discussed in this present paper, technological advancements are occurring at an increasingly rapid pace. Novel applications and new generation language models such as DeepSeek and Qwen are emerging, and as educators and learners become more familiar with these technologies, their experiences and perceptions evolve very quickly. Consequently, the findings of earlier studies might quickly become outdated. As a result, changing the period and scope of future studies, for example, including the studies in 2025, might alter the conclusions presented in this review.

Also, the databases in the present review were kept limited to EBSCOhost and JSTOR since these databases closely align with the education and language studies field, thereby helping the research to be conducted without less relevant and lower-quality results. However, conducting research based on a search of the studies on different databases such as Scopus, Web of Science, and Eric could bring about different results. Another limitation of the present review is that it focuses on language learning from a holistic approach, so the conclusions regarding one language skill might fall short in the present review; however, a different review adopting an approach mainly focusing on one aspect of language learning, for example, writing or speaking would yield more comprehensive conclusions regarding the skill. Similarly, educational levels were not limited to only a particular level in this review to reach a general understanding of AI use. This might have posed a limitation because the variation in age groups, institutional goals, and pedagogical approaches makes it difficult to derive a cohesive understanding of AI use in education. Therefore, more focused reviews that address particular education levels would be more effective in understanding the context-specific effects of AI tools better.

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Research Article

Looking at the Reform of the Century of Türkiye Education Model through the Lens of Synchronization Theory by Wearing Phenomenological Glasses

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Abstract: In 2024, Türkiye launched a reform movement that adopts the dynamics of Turkish culture to produce solutions to the chronic problems in the education system. This study aimed to understand how primary school first-grade teachers experienced this process in the early stages of the reform movement called the Century of Türkiye Education Model. 10 teachers, who were determined using the criterion sampling technique, participated in the study, which was conducted using a qualitative method and phenomenological design. In the study, data were obtained through semi-structured interviews and analyzed with content analysis. The findings showed that the teachers were thrust into a major reform process with very limited preparation. It was revealed that the teachers' inadequate knowledge about the changes introduced caused them to experience negative emotions and have negative thoughts. They transferred these negative feelings and thoughts to their behaviors by not fully fulfilling the requirements of the reform initiative. We used the synchronization theory as an explanatory way to discuss our findings. The study concluded that synchronization between policymakers and teachers is an important factor for the success of the Century of Türkiye Education Model reform initiative. In light of this important result, we offered some practical suggestions to teachers, policymakers, and researchers.

Keywords: Education Reform, Primary School First-Grade Teacher, Synchronization Theory, The Century of Türkiye Education Model, Türkiye

1. Introduction

Political, social, economic, and technological factors have put great pressure on education systems, especially since the beginning of the new century (Jiang & Saito, 2024; Organisation for Economic Co-Operation and Development [OECD], 2013, 2018, 2023; World Bank, 2016, 2018). The COVID-19 pandemic added biological pressure factors to the list, leading to further acceleration of education reforms (United Nations International Children's Emergency Fund [UNICEF], 2020; Zhao & Watterston, 2021). Therefore, most countries are trying to improve their education systems, especially because of the impact of education on social and economic well-being (Högberg & Lindgren, 2022; Sahlberg, 2016: United Nations, 2020, p. 2). Scientific circles seem to reach a consensus that teachers have a fundamental role in the success of a reform movement in education (Akala, 2021; Akpinar & Aydin, 2007; Haug & Mork, 2021; Kondakci et al., 2015; Mellegård & Pettersen, 2016; Unsal et al., 2019). However, despite this consensus in the literature, there is little research focusing on understanding exactly what teachers experience at the very beginning of a reform process (Akpinar & Aydin, 2007; Borna Khajeh et al., 2022; Terhart, 2013). Scott et al. (2024) explained in a recent comprehensive study that they conducted that teachers' readiness for change in different periods was not investigated.

Researchers tend to examine teachers' approaches to changes in education systems, generally from similar theoretical perspectives, with quantitative methods that assume the school levels at which teachers work are homogeneous (e.g. Adolfsson, 2024; Hidayah et al., 2022; Kondakci et al., 2015; Zayim & Kondakci, 2015). However, primary schools and primary school teachers have a unique place in education. Therefore, they deserve to be directly focused on (Bakx et al., 2015). Primary schools are the first step in the education life of some students in all countries, and primary school teachers are the first teachers they encounter. The quality of education students receive in primary school can affect their entire educational career (Boland, 1993; Slavin, 1993). According to Erikson's (2018) life cycle theory, students make decisions about whether they are successful or unsuccessful during their primary school

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years. In the first grade of primary school, teachers teach their students many vital skills such as reading and writing in their native language, basic mathematical skills, being a member of a social circle, the rules of common living, and basic citizenship behaviors (Erikson, 2018). While primary school first-grade teachers are imparting these very important skills to their students in their classrooms, changes in the education system may cause them to change their past practices and habits (Terhart, 2013) and disrupt the synchronization they have established with their students (Ishtiaque et al., 2023). For this reason, it was deemed worthwhile to examine the experiences of primary school first-grade teachers regarding The Century of Türkiye Education Model (CoTEM), the most recent reform initiative in Turkey.

CoTEM aims to bring about fundamental change in the Turkish education system and overcome its problems, based on a student-centered approach. CoTEM aims to support students' social, emotional, and cognitive development from an early age, develop their critical thinking, problem-solving, and technology skills, and thus raise globally competitive citizens (Ulcay, 2024). In the skill-based model, conceptual skills, subject-specific skills, social-emotional skills, literacy skills, and values are included in order to equip students with the skills required by their age, starting from the first grade of elementary school (Yildirim & Caliskan, 2024). According to the renewed curricula within the scope of CoTEM, first-grade course contents have been prepared in a way that will enable students to gain environmental awareness (Ceylan & Peker, 2024) and acquire financial, visual, and critical literacy skills (Sezer & Dedeoglu, 2024). First grade is the educational year in which students in almost all countries develop reading and writing skills in their native languages. In this regard, the CoTEM curriculum places special emphasis on the correct and effective use of the native language. The ultimate goal of the model is to raise competent and virtuous individuals (MoNE, 2024a). Given that first grade marks the beginning of academic education, it can be said that it holds particular importance in achieving this ultimate goal. It is important to understand the bottom-up responses of primary school first-grade teachers, who are responsible for the first year of academic education, to this major policy change designed top-down by policymakers, as well as their experiences during this process.

Existing literature addressed how teachers respond to change in reform initiatives carried out in different countries from the perspective of different approaches (Akala, 2021; Haug & Mork, 2021; Kaviti, 2018; Mellegård & Pettersen, 2016; Mulenga & Kabombwe, 2019). However, to our knowledge, no study has interpreted how teachers respond to an educational reform through the lens of synchronization theory. Examining an education reform initiative from a synchronization theory perspective through a phenomenological study can provide significant contributions to the expansion of theory and the existing knowledge base for education researchers. Additionally, with this study, we respond to calls in the literature to emphasize teachers' voices, understand their needs, and include their first-hand perspectives by engaging with them in ambitious reform initiatives (Haug & Mork, 2021; Kent, 2013; Mellegård & Pettersen, 2016). In our study, we seek to answer the question of how primary school first-grade teachers experienced the first stages of the reform process initiated with the Century of Türkiye Education Model.

2. Theoretical Framework

2.1. Change in education systems

Change, which is one of the operational and strategic characteristics of organizations, is simply defined as moving from one existing situation to another (Burnes, 2004). However, the transition of organizations from their current state to another, in other words the reforms they implement, often represents a process that is difficult to predict, uncertain, and quite controversial (Terhart, 2013). Therefore, in order for a planned reform movement to be successful, an effective change management process must be implemented in educational organizations and other organizations and employees must be prepared for change (Burnes, 2004; Wang et al., 2020). Although the success or failure of

education reforms is affected by many different factors, the most important of these factors is the responses of teachers to the reform initiative, which plays a decisive role (Akala, 2021; Burnes, 2004; Kondakci et al., 2015; Zayim & Kondakci, 2015). When teachers do not internalize education reforms, changes in policy documents cannot lead to changes in behavior (Hallinger & Bryant, 2013). In other words, the expected synchronization between legal texts and implementation practices does not occur.

2.2. Synchronization theory

The word synchronization, which originates from Greek, means “occurring at the same time” (Pikovsky et al., 2001, p. 17). The word synchronization is explained in dictionaries as simultaneous occurrence, occurring at the same time, equalization, time harmony, and synchrony. The phenomenon of synchronization of oscillations, discovered by Christian Huygens with a pendulum clock in 1965 (Balanov et al., 2009, p.15), is the subject of many studies, scientific articles, and books, and are defined in various ways.

Pikovsky et al. (2001) defined synchrony as a universal phenomenon that manifests itself in the adjustment of rhythms of interacting self-sustaining systems (p. 8). The realization of this phenomenon requires that objects be oscillators and autonomous systems, as well as open systems that receive signals from their environment and interact with other objects. Oscillators are self-sustaining systems and can exhibit various forms of rhythm (Pikovsky et al., 2001, pp. 8-9). This perspective on synchronization was adopted by many scientists (e.g. Balanov et al., 2009, p. 1).

In the literature, numerous examples from nature regarding the phenomenon of synchronization are presented. These were explained in a wide range of ways, from the periodic motions of the planets, to the harmony of the sounds of organ pipes, to the random opening of channels in cell membranes, to flocks of birds flapping their wings, to fireflies emitting sequences of light pulses, to the synchronized firing of neurons, to the applause of concert audiences. The common feature of these different physical and biological systems is that they produce periodic rhythms that have the capacity to adapt to each other (Balanov et al., 2009, p. 2; Eilam, 2019; Pikovsky et al., 2001, p. 17). In summary, synchronization, which we encounter in a great variety, is encountered not only in natural events but also in the physiological structures of living beings or in their social lives, in relationships, or in organizations that are a network of relationships (Balanov et al., 2009, p. 2).

The number of studies that provide a theoretical basis from synchronization theory is increasing, and these studies provide important information for understanding human behavior. For example, in his pioneering study with a group of female students living in a university dormitory, McClintock (1971) found that social and emotional synchrony among the students increasingly synchronized the physiological functioning of their bodies. Eilam (2019) suggested that the emotions that people construct can be viewed as oscillators that can synchronize with each other, and therefore, it is possible to examine emotional climate as a form of synchronization in an ensemble of oscillators. Nummenmaaa et al. (2012) conducted a study with subjects who watched a movie together and proved that the networks of brain regions of the participants who watched similar emotional events "worked together", in other words, were synchronized. Stone et al. (2006) conducted a study with 909 female employees and found that there was a rhythm in the emotions of employees throughout a working day and that a pattern was repeated. Some studies also indicated that synchronization in educational environments can produce positive results. For example, Kent (2013) redefined teaching in the context of synchronization theory and explained teaching as a natural cognitive ability that requires human interaction. Furthermore, it was noted that teaching is most optimal when there is synchrony or flow in these interactions (Kent, 2013). Degenhart and Wabara (2021) adapted the concept of simple synchronization to teaching and learning. In their experimental study, they pointed out that simple synchronization could prevent students from compromising their lessons and performance. Based on

this information in the literature, we also suggested in our study that an education reform could be examined through the lens of synchronization theory.

2.3. The context of Türkiye and the Turkish education system

The Republic of Türkiye celebrated its 100th anniversary a while ago. During this time, the number of students in Türkiye increased by 53 times, the number of teachers by 93 times, and the number of schools by 15 times (Ministry of National Education [MoNE], 2024c). Thus, in Türkiye, with a total population of over 85 million, with nearly 20 million students and more than one million 150 thousand teachers (MoNE, 2023), the Turkish education system is described as a macro system (Ozdemir et al., 2023). Compulsory education for all students in Türkiye is 12 years. After preschool education, students attend four years of compulsory primary, secondary, and high school education. In an academic year at the K-12 level, students attend school for 180 days. Students usually start their education in the second week of September and have four periods of vacation. At the beginning of each level of education, an orientation week is implemented for students in preschool, primary school, secondary school, and the first year of high school. Students in these grades start school with their teachers on the first day of September.

There were numerous reform attempts in the Turkish Education System throughout the history of the Republic (e.g. MoNE, 2017). But all these well-intentioned efforts were not enough to improve outcomes for Turkish students and increase the effectiveness of schools. The results of international comparisons and national exams show that there are significant problems with student learning in Türkiye (MoNE, 2023; OECD, 2023; TIMSS, 2019). Moreover, studies conducted in Türkiye show that the Turkish education system has chronic problems (e.g. Oldac & Kondakci, 2020). These results once again mobilized policymakers, and a major education reform called the Century of Türkiye Education Model was launched, which is planned to be gradually implemented in 2024.

Announced as an educational model specific to Turkish culture, CoTEM was put into practice with the slogan “From Roots to the Future”. The model, which was introduced as the biggest education reform that Türkiye has ever implemented, aims at the holistic development of students. The model, which places humans at its center, aims for the synchronized development of students in five developmental areas: cognitive, affective, behavioral, social, and spiritual development. The model emphasizes a rights and learning-based learning process and flexible and free learning environments. Language skills, values education, student-centered, and differentiated education are the areas emphasized in the model. The model defines curricula as concrete indicators of the educational approach and aims to reduce the pressure of an intensive curriculum, which is one of the important criticisms about the Turkish education system. The curriculum adopts a holistic approach consisting of student profile, virtue-value action framework, and skills framework components (MoNE, 2024a, p. 4). In our study, we look at the CoTEM reform movement initiated in Türkiye through the lens of synchronization theory with the experiences of teachers.

3. Method

3.1. Study design

The study was conducted using a qualitative method and a phenomenological design. Studies conducted using phenomenological designs allow the discovery of how ordinary people make sense of a phenomenon, how they experience it, and the common meanings in these experiences (Bogdan & Biklen, 2022; Creswell, 2020; Merriam, 2018). The study aims to determine the essence of the subjective responses and experiences of teachers to the process of change experienced with the CoTEM, which was started to be gradually implemented in Türkiye in the 2024-2025 academic year and was declared to be the biggest policy reform in the history of the Republic of Türkiye. It was decided that the

phenomenological design was the most appropriate design to achieve this purpose. *Teachers' response to change in an educational reform process* was determined as the phenomenon of the study.

3.2. Study group

The participants in the study consisted of 10 primary school first-grade teachers who volunteered to participate in the research and who were teaching first-grade elementary school classes. Of the teachers in the study group, 7 were female and 3 were male. One of the teachers had a master's degree, and the others had a bachelor's degree. They had been working as teachers for periods ranging from 1 to 35 years. The teachers also had different experiences of being primary school first-grade teachers. Some were first-time primary school first-grade teachers and those who were working as primary school first-grade teachers for the 10th time in their careers. Additionally, each of the teachers was working in a different schools. 3 teachers were working in a private school, and 7 teachers were working in a public school. The characteristics of the teachers who participated in the study are shown in Table 1.

Table 1

Demographic Characteristics of Teachers in the Study Group

No	Code	Gender	Seniority	Educational level	Type of school	First-grade experience
1	T-Change	Female	19	Master's degree	Private	6
2	T- Ändern	Female	12	Bachelor's degree	Private	7
3	T-Changement	Male	19	Bachelor's degree	Public	6
4	T-Cambiar	Female	20	Bachelor's degree	Public	8
5	T-Modifica	Female	19	Bachelor's degree	Public	6
6	T-Değişim	Female	18	Bachelor's degree	Private	5
7	T-Mudar	Male	35	Bachelor's degree	Public	10
8	T-Scihimba	Female	27	Bachelor's degree	Public	6
9	T-Forandring	Male	30	Bachelor's degree	Public	9
10	T-Muttaa	Female	1	Bachelor's degree	Public	1

3.3. Data collection tool and data collection

The data of the study were collected through face-to-face interviews using a semi-structured interview form. In developing the semi-structured interview form, Merriam's (2018) recommendations were followed, and the form was developed in five stages. First, the literature was reviewed in detail and the data collection tools used in similar studies were examined (e.g. Bada, 2018; Kilinc, 2014). It was examined how questions were asked to the participants in order to reveal the opinions of teachers in the measurement tools used in these studies. Secondly, a draft form was created in line with the study problems. Thirdly, the draft form was presented to the expert opinion of two academics in the field of educational administration who were experienced in qualitative research. Based on the opinion of the first expert, one question was removed from the draft form. Based on the opinion of the second expert, two probing questions were added to the draft form. Fourthly, the interview form was presented to two Turkish teachers for their opinions in terms of grammar and understandability. The Turkish expression of four probing questions that were evaluated as “partially appropriate” by Turkish grammar experts was adjusted according to the experts’ suggestions. Fifthly, a pilot scheme was conducted by testing the draft form with two primary school first-grade teachers. The teachers who participated in the pilot scheme gave feedback that the form was easy to understand. The researchers also decided that all the questions in the draft form in the pilot scheme were suitable for the study purposes. The semi-

structured interview form, which was finalized in this way, consisted of 5 demographic questions, 6 open-ended questions, and 9 probing questions and was ready to be implemented.

Some of the questions in the semi-structured interview form were as follows:

1. How do you generally evaluate the Century of Türkiye Education Model?
2. What are your thoughts on the preparation process for the implementation of the Century of Türkiye Education Model?
3. What are your thoughts on the expected applications under the Century of Türkiye Education Model?

Before the data collection process of the study began, ethical approval was obtained from Kocaeli University with decision number 2024/13-23. The participants included in the study were given detailed information about the study. Voluntary consent was obtained from the participants. Appointments were made for the interviews. The interviews took place on days and times convenient for the participants in their school libraries, an empty classroom, or the teacher's study room. The interviews were recorded with a voice recorder.

3.4. Data analysis

The data were analyzed using content analysis. Content analysis refers to systematically and objectively summarizing what is intended to be said with words and revealing the pattern in the data (Patton, 2018, p. 442). During the interviews with the participants, 473 minutes of audio were recorded. We transcribed the interviews recorded with a voice recorder into text on a computer. In this way, we obtained 112 MS Word pages of written text. We analyzed the data according to the steps of Moustakas's (1994) transcendental phenomenological model. We transferred the written data to a table we prepared for analysis. We read the data several times and removed the sentences that were considered irrelevant. The dataset, which was sorted and made ready for analysis, consisted of 2515 sentences. The researchers analyzed the data separately. We identified and marked the key expressions (memo), codes, and themes in the analysis table. It was later understood that the two researchers assigned different codes to the 236 sentences. The researchers first discussed the semantic and theoretical contexts of these sentences and then coded them by consensus. Codes were assigned to these sentences by consensus of both researchers. The findings obtained from the data were organized under themes and codes to convey the essence of the participants' experiences, visualized (Figure 1), and presented descriptively by directly conveying the participants' views. Moreover, each participant was identified with a code name to conceal their identity. For this purpose, each participant was assigned a code with the meaning of the word “change” in widely spoken languages that use the Latin alphabet. Additionally, the letter (T) was added to the beginning of the code to indicate that the participants were teachers. For example, the participant in second place was identified with the word “Ändern”, which is the meaning of the German word for change, and the participant was named with the code T-Ändern.

3.5. Measures taken for validity and reliability

In order to increase the quality of the study, we applied the strategies suggested by some important scientists in the literature regarding ensuring validity and reliability in qualitative research (Bogdan & Biklen, 2022; Creswell, 2020; Merriam, 2018; Patton, 2018). First, we discussed the information we had on the subject in order to bracket it and control researcher bias. Afterwards, we conducted a detailed literature review. We increased our interaction with the participants by conducting long-term, in-depth interviews with them. By establishing a relationship of trust with the participants, we aimed to reduce the researcher's influence on the participants and to collect depth-oriented data. We also sought assistance from experts in the development of the data collection tool and took expert review measures. We transcribed the audio recordings obtained from the interviews on a computer. We then forwarded these written documents to the participants to confirm that what they said was transcribed accurately.

We made sure that the participants were from different schools, genders, and professional experiences. In this way, we increased the credibility of the study (Patton, 2018, pp. 341, 556). We provided detailed information by making rich descriptions about the study process. We ensured maximum diversity by including a large number of teachers who had experienced the phenomenon in the study. We ensured transferability (Merriam, 2018, pp. 218-228). We recorded our interviews with the participants with a high-resolution audio recorder. Then we transcribed it on a computer (Creswell, 2020, p. 255). During the coding process, we calculated the agreement percentage between the coders using the Miles and Huberman (1994) model. We found the agreement percentage to be 90.6% due to the different codes that the researchers assigned to the 236 sentences. We considered internal consistency to be high because the agreement between the coders was greater than 80% (Miles & Huberman, 1994). Thanks to these measures, we ensured the consistency of the study (Creswell, 2020, p. 255). We directly conveyed the participants' opinions in the presentation of the findings of the study (Bogdan & Biklen, 2022, p. 195). We backed up the study data and stored it. We also made our data accessible to other researchers. In this way, we ensured the verifiability of the study.

3.6. The role of the researcher

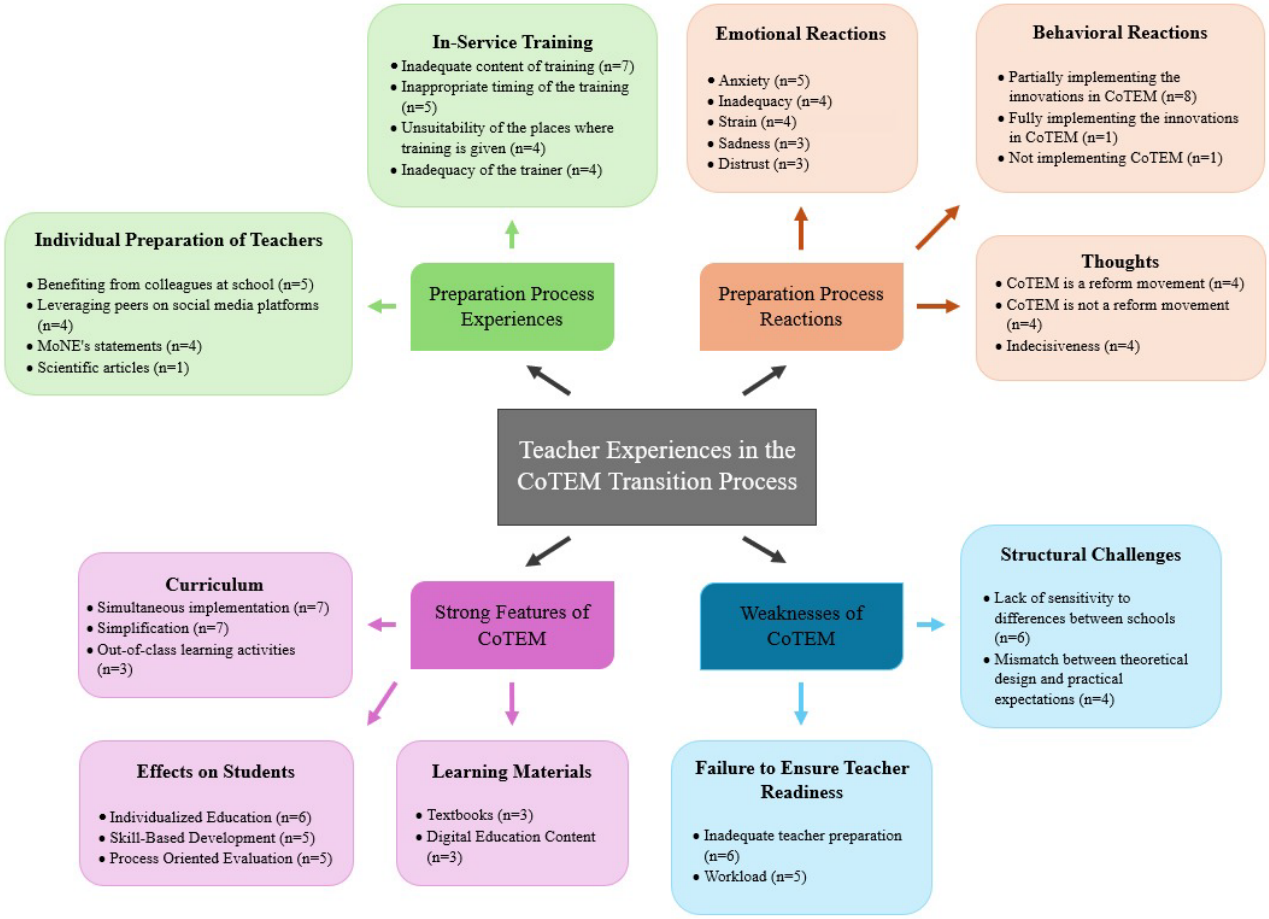
The first researcher worked as a school counselor for many years and is currently continuing her career as an academic. The second researcher is a primary school teacher. She conducted the face-to-face interviews from which the study data were obtained. Since the second researcher was a primary school teacher, it was easier to establish a trusting relationship with the participants during the data collection process. Thus, in-depth data could be obtained. The first researcher's identity as an academic and psychological counselor enabled the prejudices in the study to be controlled.

4. Findings

In the study, it was determined that the teachers' opinions and experiences regarding the transition process to CoTEM formed four themes. The first theme was named as the experiences of teachers in the CoTEM preparation process, the second theme as the reactions of teachers during the transition process to CoTEM, the third theme as the strengths of CoTEM in the experiences of teachers, and the fourth theme as the weaknesses of CoTEM in the experiences of teachers. We also identified a total of 10 sub-themes and 31 codes within these themes. The identified themes, sub-themes, and codes are shown in Figure 1.

Figure 1

Classroom Teachers' Experiences in the Reform Process of the Turkish Century Education



4.1. Theme 1: Experiences of teachers in the CoTEM preparation process

We identified two sub-themes related to teachers' experiences with the CoTEM preparation process. We named these sub-themes "in-service training" and "individual preparation of teachers." The in-service training sub-theme included four codes (inadequate content of training, inappropriate timing of the training, unsuitability of the places where training is given, inadequacy of the trainer), and the individual preparation of teachers' sub-theme also included four codes (benefiting from colleagues at school, leveraging peers on social media platforms, MoNE's statements, scientific articles).

The first sub-theme includes the experiences of teachers in the in-service training organized by MoNE to prepare teachers for CoTEM. All teachers reported negative experiences with the in-service training organized by MoNE. The teachers stated that there were important problems regarding the content, time, and place planning of in-service training and the qualifications of the educators providing it. According to the experiences of teachers, the in-service training only included theoretical knowledge and was insufficient to acquire practical skills. The teachers also negatively evaluated the fact that the in-service training was held in the first week of September and lasted only three days. For example, T-Değişim expressed this as follows: "*The first week of September is the week of adaptation to school for first-grade primary school students. Since we were in in-service training, we could not do adaptation activities with our students. In any case, a three-day training was not enough time for us to learn this model.*" The teachers also explained that the meeting rooms where CoTEM information trainings were held prevented them from doing practical applications and that the trainers who provided information about the model had very limited knowledge about the model. A striking finding in the study was that

three of the teachers (two private school teachers and one public school teacher) did not attend the events organized by MoNE.

The second sub-theme includes their experiences regarding their own preparations for CoTEM. The teachers explained that since they were not adequately prepared for the change by MoNE, they sought help from different sources of information to adapt to the process. They stated that they mostly learned from their colleagues at their schools and from their colleagues on social media platforms. Other sources of information for teachers were written explanations by MoNE and scientific articles.

4.2. Theme 2: Reactions of teachers during the transition process to CoTEM

We identified three sub-themes related to teachers' reactions during the transition to CoTEM. We named these sub-themes "emotional reactions," "behavioral reactions," and "thoughts." The emotional reactions sub-theme included five codes (anxiety, inadequacy, strain, sadness, distrust), the behavioral reactions sub-theme included three codes (fully implementing the innovations in CoTEM, partially implementing the innovations in CoTEM, not implementing CoTEM), and the thoughts sub-theme included three codes (CoTEM is not a reform movement, CoTEM is a reform movement, indecisiveness).

The first sub-theme includes the experiences of teachers regarding their emotional reactions during the transition process to CoTEM. The teachers explained that they experienced negative feelings toward themselves and policy makers. The most intense emotion that teachers felt for themselves during the process was anxiety, followed by inadequacy, difficulty, and sadness. For example, T-Modifica and T-Scihimba said that there were times when they cried due to the anxiety and feeling of inadequacy that they experienced during the transition process to CoTEM. T- Ändern explained the emotional difficulty she experienced with the words, *"…my past knowledge and habits make it difficult for me to learn new things. This constantly gives me a feeling of strain. I don't like this feeling.*" The most common feeling teachers experienced for policy makers was distrust. For example, T-Changement expressed the feeling of distrust he experienced with the words, "*They (policy makers) did not ask anyone (teachers) when they introduced this model. They will not ask anyone when they remove it either. Like the others (previous policy changes), this one will also be shelved in a short time*."

The second sub-theme includes the experiences of teachers regarding their intellectual reactions during the transition process to CoTEM. The teachers had different opinions about whether CoTEM is a real reform movement. Some teachers thought that CoTEM is a great reform movement, while others thought that it cannot be considered a change movement. Some of the teachers also said that they were undecided about CoTEM. For example, T-Muttaa thought that the model is a major reform movement. T-Change's words, "*A promising model for the future. This is a vaccine study…*" and her explanation of the changes made with CoTEM with the vaccine metaphor show that she evaluated the model as a reform movement. T-Scihimba's statement that "*it did not bring any significant changes. What was said before is now being explained with other concepts*" shows that she did not think CoTEM was a reformist initiative. It is understood from T-Cambiar's sentence, "*We could not fully understand what The Century of Türkiye Education Model is*," that she was undecided about the model.

The third sub-theme includes the experiences of teachers regarding their behavioral reactions during the transition process to CoTEM. It was determined that the majority of teachers partially transformed the changes brought by CoTEM into behavior and partially implemented them in their classes. T-Muder explained this with the words, *"…first, I show the students how to write the letters as suggested in the new model. Then I teach them as I know*." It was understood that one teacher (T-Modifica) did not implement any innovations in the model, and one teacher (T-Muttaa) carried out her class work in full compliance with the new model.

4.3. Theme 3: Strengths of CoTEM in the experiences of teachers

We identified three sub-themes related to teachers' experiences with the strengths of CoTEM. We named these sub-themes "learning materials," "effects on students," and "curriculum." The learning materials sub-theme included two codes (textbooks, digital education content), the effects on students sub-theme included three codes (individualized education, skill-based development, process-oriented evaluation), and the curriculum sub-theme included three codes (simultaneous implementation, simplification, out-of-class learning activities).

The first sub-theme includes the experiences of teachers regarding the features they found strong in CoTEM's curriculum. According to the experiences of teachers, the curriculum being implemented simultaneously in all classes in Türkiye, the simplification of the curriculum, and the inclusion of out-of-class learning activities into the curriculum were the curriculum-related features that they found strong in the model.

The second sub-theme includes the experiences of teachers regarding the features they found strong about CoTEM's learning materials. According to the experiences of teachers, the textbooks and digital course materials prepared for the new model were the course materials-related features that they found strong in the model. The teachers expressed their satisfaction with the inclusion of QR codes in the textbooks and the fact that the books were designed to be skill-based. They also stated that the digital course content within the EBA (Education Information Network) digital platform created by MoNE is among the strong features of the model.

The third sub-theme includes the experiences of teachers regarding the features they found strong in terms of the reflection of CoTEM on students. According to the experiences of teachers, the strengths of CoTEM were that the model was sensitive to individual differences of students, aimed at developing students in a skill-based manner, and adopted process-oriented evaluation.

4.4. Theme 4: Weaknesses of CoTEM in the experiences of teachers

We identified two sub-themes related to teachers' experiences with the weaknesses of CoTEM. We named these sub-themes "failure to ensure teacher readiness" and "structural challenges." The sub-theme of failure to ensure teacher readiness included two codes (inadequate teacher preparation, workload), and the sub-theme of structural challenges included two codes (lack of sensitivity to differences between schools, mismatch between theoretical design and practical expectations).

The first sub-theme includes the experiences of teachers regarding the problems caused by passing the CoTEM without ensuring their readiness. The fact that teachers were not adequately prepared for the education reform that affected the whole of Türkiye, and the model increased the workload by defining too many forced tasks for teachers was thought to be the weaknesses of the model by the teachers. For example, T-Muttaa, who worked in a public school and was only in her first year in the teaching profession, said, "*…I am a teacher working in a public school. In order for the state to entrust children to me, I have to undergo serious training* […] *In such a new system, they should have expected the teacher they entrust the children to be aware of everything. Of course, they should have made an effort to meet this expectation*," showing that MoNE failed to ensure teachers' readiness for a major change. T-Forandring explained the workload created by the model as follows: *"… after each activity we do, we fill out dozens of pages of paperwork. We record the codes defined for the topics we cover in each lesson. This never ends. I have 32 students in my class. I spend ten minutes of each lesson on these ridiculous tasks*."

The second sub-theme includes the experiences of teachers regarding the structural problems of CoTEM. According to the experiences of teachers, the fact that not all schools in Türkiye have equal resources and the contradictions between the theoretical design of the model and practical expectations were structural problems experienced by the teachers in the model. While the teachers considered

CoTEM's adoption of an activity-based approach as a positive feature, they explained that not all schools in Türkiye have the human and material resources to carry out these activities. They stated that some schools are located in disadvantaged areas and do not even have basic stationery. For example, T-Modifica's experience, *"…in my school, most of the students come from poor families. The school does not have money either. I bought the necessary materials for the first few activities myself. But I could not do the following activities because families do not have the money to buy the materials. The school does not have internet to access digital content*," shows that the model cannot be applied in the same way in all schools. T-Changament explains the discrepancies between the theoretical design of the model and practical expectations by the fact that although the model claimed that it simplified the curricula, the curricula of some subjects (e.g., mathematics) were made more intensive than the previous curricula. T-Değişim stated that although the activity-based approach and differentiated teaching model were adopted in the theoretical design of the model, this expectation could not be met in practice due to the large number of students in the class, inadequate classroom furniture, and small classroom space.

5. Discussion, Conclusion, and Recommendations

This study aimed to explore the experiences of teachers in the transition process to the Century of Türkiye Education Model, which was announced to the public as the biggest education reform of the century in Türkiye and started to be implemented in September 2024. When the study data were analyzed, four broad themes with sub-themes emerged. The findings demonstrated that this major reform initiative was implemented before teachers were adequately prepared for the change. In the study, it was understood that the teachers could not be convinced about the necessity of change, and that the teachers were asked to apply the model in their classes without gaining theoretical and practical skills. It was determined that the teachers who were caught unprepared for a major change showed negative emotional reactions such as anxiety, inadequacy, difficulty, and insecurity, and exhibited resistance behaviors by partially reflecting the change brought by the model into their classroom practices. It was understood that although the teachers thought that CoTEM has features that can provide positive change in the education system, they believed that the model has significant structural problems due to its approach that considers all regions and schools in Türkiye as homogeneous. We discuss these findings by borrowing the lens of synchronization theory.

Education reforms are primarily carried out to provide solutions to systemic problems, increase the effectiveness of schools, and improve student outcomes (Akala, 2021; Hargreaves & Fullan, 2009). The last education reform in Türkiye aimed to nationalize the education system, adopt an education model that is sensitive to the country's own culture, and eliminate the deficiencies identified through national and international exams (MoNE, 2024a). In an education reform, teachers are seen as strategic change agents (Hargreaves & Fullan, 2009). Teachers are at the heart of the process, transforming abstract policies into concrete student outcomes (Akala, 2021; Unsal et al., 2019). In particular, in reform initiatives aimed at changing teaching programs, it is important to include teachers in all stages of the change process in order to successfully manage the process. (Kirk & Macdonald, 2001). As part of the CoTEM reform initiative, MoNE announced that it would include all first, fifth, and ninth-grade teachers in Türkiye in face-to-face in-service training simultaneously in the first week of September 2024 so that they could implement the innovations brought by the change. It aimed to inform all teachers about CoTEM and to provide them with practical skills through in-service training (MoNE, 2024b). However, the findings of the study showed that not all teachers were able to participate in in-service training. The teachers who participated in in-service training also shared generally negative experiences regarding the training. The study results showed that the teachers found in-service training to be very inadequate in terms of content, time, and place planning, and that they actually gained theoretical and practical skills about the model by sharing knowledge, experience, and materials with their colleagues. These results supported the literature that teacher trainings carried out with the traditional approach based

on knowledge transfer make little contribution to development of teachers (Cilliers et al., 2020; Darling-Hammond & Richardson 2009; Guskey, 2002), and that contemporary approaches that allow teachers to learn from each other were more effective in teacher professional learning (Hilal et al., 2022; Liu et al., 2016; Thien & Yeap, 2023).

Studies in literature highlight the importance of teacher training in improving student outcomes (Hallinger & Kulophas, 2019; Liu et al., 2016; Orphanos & Orr, 2013; Thien & Yeap, 2023). This scientific evidence led many countries to make policy changes in teacher training (OECD, 2019; MoNE, 2018). In recent years, Türkiye has adopted a school-based approach for teacher training. It was documented in policy documents that teacher training should be carried out in ways that allow teachers to interact with each other and gain practical skills (MoNE, 2018). However, the findings of the study showed that, on the contrary, CoTEM teacher preparation training was carried out in line with Türkiye's past habits, indicating that MoNE cannot ensure synchronization between the policies it determined. According to the findings, teachers did not acquire the necessary knowledge and skills for the activities planned within the scope of CoTEM through the in-service training activities organized by MoNE. It is important for teachers to have access to effective in-service training activities in order to develop their skills and, in particular, to improve their competence in the different teaching methods included in CoTEM, which aims to bring about a major change in education (Karjalainen et al., 2022). Indeed, similar to the findings of this study, other studies also indicate that teachers experience difficulties in implementing CoTEM activities and require in-service training (Duyul et al., 2025; Uludag-Kircil & Ulucinar-Sagir, 2025). Teachers' lack of knowledge and skills led them to develop negative emotions, thoughts, and behaviors.

It was understood that the most intense feeling that almost all of the teachers who participated in our study felt about themselves during the change process was anxiety, and the most intense feeling they felt about policy makers was distrust. It was determined that the majority of the teachers who participated in the study thought that CoTEM was not a real change movement and that they turned these thoughts into behavior by not transferring the innovations brought by the model to their classroom practices. In other words, teachers were synchronized in their feelings of anxiety and distrust, in their belief that CoTEM does not contain innovations, and in their behavior of continuing to use their old methods in their classroom activities. Similar to the findings of this study, other studies in the literature also provide evidence that people can synchronize their emotions, thoughts, and behaviors (Ishtiaque, et al., 2023; Lindenberger et al., 2009; McClintock, 1971; Nummenmaaa et al., 2012; Stone et al., 2006; Zheng et al., 2020). For example, in a study conducted in England by Moore et al. (2002), it was found that the teachers defined themselves in different ways and felt uneasy in the face of pressure for reform. Kondakci et al. (2015) conducted a study with a large dataset of primary school teachers in Türkiye and examined teachers' readiness for change. The results of the study were impressive. The study proved the importance of some very important emotional and cognitive variables, such as trust and job satisfaction, which actually need to be formed before the change process, in order for the change to be successful (Kondakci et al., 2015). It is known that positive emotions, thoughts, and behaviors of teachers have a great impact on learning experiences and achievements of students (Acton & Glasgow, 2015; Shao, 2023). Based on the results of previous studies, this study led us to conclude that teachers participating in this study could spread their negative feelings and thoughts to their students, thereby reducing the effectiveness of CoTEM.

An education reform often announces ambitious goals (Haug & Mork, 2021; Högberg & Lindgren, 2022). The reforms implemented target not only students, teachers, parents, but also society as a whole due to the widespread impact of education (Hargreaves & Fullan, 2009; Oruc & Ulusoy, 2008; World Bank, 2018). Therefore, a reform in education requires a collective effort and the synchronization of all components of the system. According to Balanov et al. (2009), synchronization is technically a result of the interaction of different systems (p. 2). Arenas et al. (2008) state that synchronization is a

phenomenon that characterizes complex systems. The Turkish education system exhibits the characteristics of a macro system with its large student and teacher population (Ozdemir et al., 2023). Pikovsky et al. (2001) point out that if the systems are intelligently combined, they can start exhibiting common behaviors simultaneously. Based on this, it can be argued that in an education reform, the intelligent integration of all actors (educational materials, employees, policies, units) within the education system with effective planning can enable them to exhibit common behaviors simultaneously around the goals. Otherwise, situations that Pikovsky et al. (2001) describe as phase shift and asynchronization may occur. As a result, a costly reform initiative may turn into a losing battle (Hargreaves & Fullan, 2009).

Some of the findings identified in our research during the implementation phase of CoTEM are similar to the results of other studies conducted on the subject (e.g., Duyul et al., 2025; Kucuk & Kurt, 2025). Uygun and Akgul (2024) conducted a study with social studies teachers and found that teachers emphasized some positive and negative features of CoTEM, believed that the activities planned under CoTEM could not be implemented in the same way due to the fact that not all schools in the country have the same resources, and determined that teachers were not sufficiently involved in the reform process. Similarly, Arslan (2025) found in his research with primary school teachers that schools faced difficulties in implementing CoTEM activities due to a lack of materials. Ulcay (2024) states that schools, especially those in rural areas, may have difficulty implementing the model effectively due to inadequate infrastructure, and that it is important for teachers to receive sufficient training to be able to apply the new approaches required by the model. The results of some studies on previous reform initiatives implemented in Turkey are similar to this study in that some teachers believe that change is not necessary and that the planned changes will not improve student achievement (Unsal et al., 2019), and that change processes occur frequently and create a workload for teachers (Cetin, 2017). In other words, teachers exhibit similar reactions to change processes.

Studies conducted in different countries show that there are some common aspects in the failure of education reforms (e.g. Kaviti, 2018). As in our findings, starting a reform initiative without adequate preparation of teachers, teachers not fully understanding the changes in the curriculum that they will implement in their classrooms, and not being able to create a synchronized understanding of the change (Kondakci et al., 2015; Mulenga & Kabombwe, 2019) are some of the reasons why education reforms fail. Because the success of educational reforms may depend on the competencies, beliefs, and attitudes of teachers during this process of change (Fullan, 2007; Ornstein & Hunkins, 2014). Another reason is that when policy makers decide on a reform initiative, they bring with them a cognitive illusion, an incorrect positive belief that this will be met with the same feelings and thoughts by teachers (Terhart, 2013). Indeed, Mellegård and Pettersen (2016) found in their study conducted in the Netherlands that policymakers introduced a new curriculum as an increase in teachers' freedom, but teachers, who were the implementers, did not perceive this change as real freedom. Other possible reasons include the hierarchical understanding that sees teachers as social creatures and robots that obey instructions, ignoring the impact of their emotions on their behaviors (Cuban, 2011; Kondakci et al., 2015). The latter is especially evident in centralized education systems such as Türkiye (Yilmaz, 2022).

We agree with Haug and Mork (2021) that the needs of teachers need to be understood when faced with new and ambitious goals such as a reform initiative. Teachers appreciate their strategies and expertise, which are based on years of accumulated experience (Seligman, 2019). Teachers understandably prefer the methods they know and their daily routines to new practices. Additionally, schools are challenging environments in many ways, and teachers have limited time due to the large number of tasks they need to handle during a school day (Desimone & Garet, 2015; Haug & Mork, 2021). In fact, the results of the Teaching and Learning International Survey [TALIS] (2018) show that the majority of teachers in Türkiye consider themselves competent in teaching, but they also experience burnout due to excessive

physical and mental fatigue. Therefore, for these and other reasons, it may take some time to convince teachers of the necessity of an education reform and to ensure synchronization among all teachers on the issue (Kent, 2013). Synchronization is a natural phenomenon in which autonomous objects that produce periodic rhythms adjust these rhythms to each other (Eilam, 2019). Education systems produce many periodic rhythms. Examples of these periodic rhythms are the continuous inclusion of students into the education system and their removal from the system as graduates, the employment of teachers as employees and their retirement from the system at the end of their careers, or the teaching of the curriculum of any course and the measurement of gains. In this sense, education systems can be described as autonomous objects that produce periodic rhythms. The fact that these rhythms within the education system move in harmony, in other words, they are simultaneous, reveals synchronization. The synchronized operation of the entire system can also enable teachers to take education reforms more into their scope of acceptance.

As a result, this study enabled us to draw some important theoretical and practical conclusions and offer practical recommendations. The study showed that synchronization theory is a stimulating and useful theory in all processes of education in general and in the examination of an education reform initiative in particular. Thus, it enabled us to examine synchronization, defined as a universal phenomenon, with a phenomenological approach in the context of education reforms. This study was understood that the process of change, which was put into practice in Türkiye in September 2024 and prepared by MoNE officials according to the Turkish culture and introduced as the biggest reform initiative in the history of the Republic of Türkiye, could not be operated in a synchronized manner. Firstly, it was seen that MoNE was not able to prepare teachers for CoTEM in a synchronous manner. This lack of synchronization can act like a domino effect and negatively impact other components of the training. Secondly, it was understood that in-service training was planned inadequately, and it was concluded that synchronization in planning could not be achieved. In other words, MoNE could not convince teachers about the necessity of the change and could not prepare them for the change. This situation led teachers to develop some negative emotional, intellectual, and behavioral reactions. The teachers generally felt a sense of anxiety for themselves and distrust for policy makers. Additionally, they had the idea that CoTEM was not a real change movement, and they turned these thoughts into behavior by not fully transferring the changes brought by the model to their classroom practices. In summary, the teachers showed a kind of passive resistance with feelings such as anxiety and distrust, thoughts that the model was not a change movement, and behaviors such as not transferring the changes to classroom practices. In this case, it was concluded that the teachers were synchronized in showing passive resistance. Teachers' synchronization in passive resistance may lead an education reform to face the threat of failure.

As a result of the research, considering that teachers' support for the reform is a critical precursor for an education reform to be successful (Wang et al., 2020), we recommend that teachers prepare for change in proactive ways in the following processes. For example, the creation of teacher professional learning communities where teachers can share their experiences regarding CoTEM in their schools can be encouraged. We also suggest producing rapid solutions that will ensure synchronization among the stakeholders of education so that the problems that arise during the change process do not negatively affect the success of the students. For example, in future studies to be carried out within the scope of CoTEM, communication channels such as social media accounts and telephone lines can be established thanks to which opinions of teachers are actively evaluated.

6. Limitations

This study, which was conducted with qualitative methods and phenomenological design, has some limitations. It is recommended that the reader interpret the study considering the limitations explained. Firstly, due to the nature of the qualitative method, the study focused on the experiences of a limited

number of participants. Therefore, the results of the study can be evaluated within its own context. In future studies, quantitative studies can be conducted with larger data sets, following other methods in the literature (Borko, 2004). Secondly, the data in the study were obtained through depth-oriented semi-structured interviews. The fact that other data collection methods such as focus group interviews and observation were not used in the study can be explained as a limitation. Thirdly, the design of the study, which only addressed the experiences of teachers regarding a reform initiative, has direct implications. The fact that the experiences of other stakeholders such as school administrators, students, and parents were not included in the study is another limitation of the study. Finally, although necessary precautions were taken to control study bias, the fact that the researchers themselves were stakeholders in the education system may have infected the study with their biases.

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Research Article

The Validity and Reliability Study of the Teacher Autonomy Scale

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Abstract: This research aimed to develop a Teacher Autonomy Scale (TAS) to determine teachers' perception levels of autonomy. This study aimed to create a measurement tool that can measure teachers' educational and teaching duties and management duties in a single dimension. TAS was applied to teachers at different branches working in the Küçükçekmece District of Istanbul Province in the 2023-24 academic year, and the analysis phase was conducted using the collected data. The participants of the study were selected according to the convenience sampling method. The trial form of the 28-item scale was applied to 201 teachers. The item pool was examined by three measurement and evaluation experts, three teachers, three school administrators, a Turkish language expert, and a 28-item trial form of the scale was created. The trial form of the scale was created as a five-point Likert-type rating scale with response options of strongly agree, agree, undecided, disagree, and strongly disagree. A preliminary application study was conducted with 40 teachers working in different branches. As a result of the trial application, the final version of the scale, consisting of 15 items, was obtained with expert opinions. The reliability and validity studies were carried out on the remaining 198 teachers. As a result of exploratory factor analysis (EFA), a single-factor structure consisting of 15 items was obtained, and the unidimensional factor explains a total variance of 57.896%. Then, confirmatory factor analysis (CFA) was conducted with a different sample of 348 teachers to test the structure revealed by EFA. All factor loadings in the CFA model were determined to be statistically significant ($p<.05$). Fit indices calculated with CFA show that the scale is valid and reliable enough to be used for different sample groups. The factor structure of the TAS was confirmed as one factor named 'Teachers' autonomy within the classroom and school'. As a result of the reliability analysis of the final form of the scale, the alpha coefficient was found to be .89.

Keywords: Teacher Autonomy, Reliability, Validity

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1. Introduction

Teacher autonomy entails that educators have a certain level of authority and freedom in matters related to their profession. This area of authority and freedom includes various issues such as teachers making decisions about their profession as 'experts' (Ingersol, 2007), organizing their working environments as they see fit (Pearson & Hall, 1993), and participating in the planning, development, and management of education (Freidman, 1999). Teacher autonomy concerns not only the expansion of authority but also issues such as increasing the professional competence of teachers and providing them with all kinds of pedagogical support that can help them improve their teaching activities (Bustingorry, 2008; Steh & Pozarnik, 2005).

1.1. Theoretical framework

1.1.1. Teacher autonomy

Definitions of teacher autonomy have been made over time, focusing on different dimensions. Little (1990), Tort-Moloney (1997), and Smith (2000) focus on the ability of teachers to engage in self-directed professional development in their definition of teacher autonomy. According to them, an autonomous teacher is a teacher who is aware of when, where, and how to acquire and use educational skills and current knowledge. The definitions made by Little (1990) and Tort-Moloney (1997) are definitions made by theorists working on learner autonomy. Although these definitions examine teacher autonomy in detail, they do not address the element of teacher behavior. When the behavioral element is added, teacher autonomy can be defined in three dimensions: competence and freedom in knowledge,

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skills, and behavior (Yan, 2010, pp. 175–176). According to Pearson and Moomaw (2005), teacher autonomy is described as teachers' feeling of being able to control their work environment and their competence. According to Freidman (1999), teacher autonomy means the formation of teacher power. Ingersol (1997) defined teacher autonomy as the individual autonomy that teachers exercise over joint decisions regarding planning and education in their own classrooms or school policies. Kreis and Young Brockopp (2001) also emphasized the concepts of "control, influence, participation, and authority," which stand out in Porter's (1989) definition of teacher autonomy. McGrath (2000) emphasized two dimensions of teacher autonomy. The first of these is the actions and developments directed by the teacher, and the second is independence from the control of others. Franklin (1988) stated that teacher autonomy can emerge when teachers see themselves as competent authorities in their field, believe that they have the right to manage the educational process, and general school rules are replaced by flexible rules that teachers deem appropriate in the classroom. While Lamb (2007) defines teacher autonomy as the capacity of teachers to improve their teaching and the freedom to teach in ways that the teacher determines, Anderson (1987) similarly defines it as the professional development or actions that teachers manage themselves, being independent from the control of others. Smith (2001) defines teacher autonomy in six dimensions: professional action directed by the teacher himself (Autonomous Teaching), the teacher having professional competence (Technical Dimension), the teacher being independent in using professional action (Political Dimension), professional development directed by the teacher (Autonomous Teacher Learning), the teacher's competence in self-directed professional development (Technical Dimension), and the teacher's independence in using professional development (Political Dimension).

Upon examination of the definitions, it is evident that teacher autonomy is narrowly defined as the teacher's reflection of his own choices and decisions on the education and training activities in the classroom, arising from the nature of education and training activities (Üzüm, 2014). Research has shown that teachers around the world generally have autonomy, and the enclosed classroom structure gives them a certain freedom (Anderson, 1987). When teacher autonomy is viewed from a broader perspective beyond the freedom teachers have in the classroom, it will be accepted that it is a phenomenon that expands teachers' powers, increases their participation in management and decision-making mechanisms, and improves teachers' roles in determining the quality and structure of education and training (Freidman, 1999; Üzüm, 2014).

1.1.2. Dimensions of teacher autonomy

Based on the definitions made regarding the concept of teacher autonomy, we see that teacher autonomy is examined in three dimensions: planning and implementation of teaching, professional development, and participation in management processes. In practice, the issues where teachers have the widest autonomy and can exercise the most authority are those directly related to classroom teaching activities (Anderson, 1987). To improve the quality of education, teachers need to be given full authority to determine methods according to the needs and characteristics of their learners, and to choose and apply their materials freely (Freidman, 1999). It is a widely accepted view in the education literature that teachers should have autonomy not only in choosing teaching methods and materials but also in choosing teaching content (Freidman, 1999; White, 1992).

Freidman (1999) divides teacher autonomy into two groups: pedagogical autonomy and organizational autonomy. Educational autonomy is directly linked to education and training, while organizational autonomy is associated with issues such as participation in school management. Teachers' increasing participation in the processes of organizing school operations, managing financial and human resources, improving the school environment, making decisions to achieve goals, and implementing the decisions taken also increases teachers' demands for authority and autonomy (Üzüm, 2014). Steh and Pozarnik (2005) argue that teacher autonomy is directly linked to the teaching profession, encompassing values,

field knowledge, professional knowledge, and application competencies. From this perspective, it has been stated that another element of teacher autonomy is the professional development of teachers. Since in-service training of teachers supports the professional development of teachers, it also appears as a determining factor in the development of teacher autonomy (Castle, 2004). However, as Bustingorry (2008) emphasizes, autonomy is a competence that cannot be achieved at once and permanently but must be developed continuously. In addition to in-service training programs, teachers need to work collaboratively as a team in developing autonomy (Üzüm, 2014). The diversity and quality of all resources provided to teachers are also important factors affecting teacher autonomy and the use of this area of autonomy (Mustafa & Cullingford, 2008).

When the educational sciences literature was examined, it was seen that there were different measurement tools developed to reveal teachers' perception of autonomy. Üzüm (2014), Karabacak (2014), Ulaş and Aksu (2015), Çolak (2016), and Karadeniz and Fer (2023)'s research shows that they developed a measurement tool to reveal the level of teacher autonomy at the local level. Additionally, it was observed that the scales developed by Leiter (1981), Pearson and Hall (1993), Archbald and Porter (1994), Freidman (1999), and Vangrieken et al. (2017) were widely used in international literature. In these studies, it has been observed that the dimensions of teacher autonomy, such as teaching autonomy, curriculum autonomy, professional development autonomy, professional communication autonomy, administrative autonomy, and financial autonomy, have been developed. In addition, as a result of the review of the measurement tools, it was observed that the number of items in the scales increased with dimensionality. This limitation is based on the fact that the teaching and management duties of the teacher are included as a dimension of teacher autonomy in all studies in the literature. While developing this scale, which will contribute to the field by making the perception level of teacher autonomy more concrete and simplified, the most basic and concrete duties of teachers were taken as the basis.

As a result of the literature review, it was seen that teachers' perception of autonomy developed primarily within the framework of teachers' educational and teaching duties and management duties, and this study aimed to develop a measurement tool that can measure these elements in a single dimension.

In addition, considering teachers' pivotal roles in the education system and their centrality in educational science research, it is fair to say that their workload and responsibilities are substantial. Participants in research studies prioritize the applicability and practicality of measurement tools, directly impacting participant numbers. Given the imperative for measurement tools to not only demonstrate validity and reliability but also be practical, it is evident that the scale developed in this research aims to contribute as a valuable measurement instrument to the literature.

2. Method

This section includes detailed explanations about the participants who participated in the development process of the Teacher Autonomy Scale, the implementation process, information about data analysis, as well as the examination of the obtained data in terms of EFA assumptions.

2.1. Participants and procedure

An online survey was set up to develop and test the psychometric properties of the TAS (Teacher Autonomy Scale). TAS was applied to 201 teachers from different branches working in the Küçükçekmece District of Istanbul Province in the 2023–2024 academic year, and the analysis phase was conducted using the collected data. The participants of the study were selected according to the convenience sampling method. Convenience sampling, also known as availability sampling, is a non-probability sampling technique. Researchers select easily accessible and convenient individuals or units to participate in a study. This method relies on the ease of access rather than random selection from the

population, making it a practical choice in many research contexts (Neuman, 2014; Bryman, 2016). The use of the convenience sampling method limits generalizability, and in this study, the results are only valid for the groups included in the sample and generalizability is limited. The data collection stage spanned from December 2023 through January 2024. In the Exploratory Factor Analysis (EFA) study, 67.2% of 198 teachers were female, and 32.8% were male. In the Confirmatory Factor Analysis (CFA) study, 51.4% of 348 teachers were female, and 48.6% were male.

2.2. Scale development process

To prepare the trial form of the scale developed to determine the level of teachers' autonomy perception, qualitative data analysis was first conducted by interviewing teachers. To determine the structural validity of the Teacher Autonomy Scale, both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted. This section includes analyses related to the validity and reliability studies of TAS.

2.2.1. Teacher Autonomy Scale (TAS)

To prepare the trial form of the scale developed to determine teachers' autonomy perception levels, 12 teachers working in different fields were interviewed. In the qualitative content analysis, themes were created from the interviewed teachers' statements, taking into account the dimensions of teacher autonomy in the studies cited in this study, and the scale item pool was obtained. Regarding the content validity of the TAS, the draft form was reviewed by three measurement and evaluation experts, three teachers, three school administrators, and a Turkish language expert. The item pool was examined by the same experts, and a 28-item trial form of the scale was created. The trial form of the scale was created as a five-point Likert-type rating scale with response options of "strongly agree," "agree," "undecided," "disagree," and "strongly disagree." A preliminary application study was conducted with 40 teachers working in different branches. As a result of the trial application, the final version of the scale, consisting of 15 items, was obtained with expert opinions.

2.2.2. Data analysis

During the scale development process, establishing construct validity is critical for ensuring the accuracy of the scores obtained from the scale. Construct validity assesses the precision of conclusions drawn about unmeasurable factors based on measurable factors (Çokluk et al. 2010). The factor analysis technique is commonly used to evaluate the construct validity of scales developed in the social sciences (Büyüköztürk, 2010; Hughes, 2018; Nunnally & Bernstein, 1994; Thompson, 2004). The two main approaches in factor analysis are exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). In exploratory factor analysis, researchers strive to categorize related variables in the early stages of their study to define and summarize the dataset effectively (Pallant, 2011; Tabachnick & Fidell, 2019). Conversely, in confirmatory factor analysis, the objective is to examine hypotheses or theories relating to the structure created based on the interrelationships between variables using intricate and advanced analyses (Büyüköztürk, 2010; Tabachnick & Fidell, 2019). In this study, both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to determine the construct validity of the Teacher Autonomy Scale. As part of the reliability studies, Cronbach's alpha, McDonald's omega, and standardized Cronbach alpha coefficients were calculated.

2.2.3. Examination of data obtained from TAS in terms of EFA assumptions

In order to ensure that the data obtained from TAS satisfied the analysis assumptions, the first step involved checking for any missing data in the datasets. As a result of the missing data analysis, it was determined that the missing data were randomly distributed, and the mean of the series was used to replace the missing data. Little's MCAR test: $\chi^2 = 43.565$, df = 56, p = .887. Then, the dataset was examined for multivariate outliers with the help of Mahalanobis distance, and extreme values were

eliminated from the dataset using this method. In the calculation made with SPSS, the significance of Mahalanobis distance was tested with 1 - χ^2(df = number of items - 1). In the dataset of 201 teachers, 3 data points that were significant at the α = .001 level were removed, and a dataset of 198 teachers was obtained. The EFA study was applied to data obtained from the 198-teacher sample group. This dataset was examined for multicollinearity problems through tolerance, condition index, and variance inflation factor. The tolerance values ranged from 0.37 to 0.64, and the variance inflation factor ranged from 1.56 to 2.70. Since the condition index value was greater than 30, it was observed by examining the plot graph that the correlations of the items were less than 0.90. Thus, it can be concluded that there is no issue of multicollinearity (Tabachnick & Fidell, 2019).

It was examined whether the obtained dataset met the multivariate normal distribution condition. For this purpose, Mardia's skewness coefficient value (Mardia, 1970) was used. Accordingly, the dataset did not exhibit a multivariate normal distribution (Mardia skewness coefficient = 3795.55, $p < .05$). In addition, it can be said that the skewness coefficients of the variables varied between -2.70 (item 1) and -1.09 (item 9), and the kurtosis coefficient varied between -0.48 (item 2) and 9.81 (item 1). Since the dataset does not exhibit a multivariate normal distribution, unweighted least squares (ULS), which is robust against the violation of this assumption, was used as the factor extraction method in the EFA (Brown & Moore, 2012). Before performing EFA, the sphericity test result recommended by Bartlett (1950) was examined. According to the results of Bartlett's sphericity test obtained from the information scale data, the correlation matrix differs from the identity matrix ($\chi^2 = 7052.90$; df = 105; $p < .001$). Additionally, the KMO value obtained from TAS data is 0.868. Accordingly, it can be said that the sample is at a meritorious level (Kaiser & Rice, 1974; Leech, et al., 2015). A polychoric correlation matrix was used when performing EFA with TAS data. Analyses were carried out using the Factor 12.04.04 software (Lorenzo-Seva & Ferrando, 2020).

3. Results and Findings

Evidence was collected for the construct validity and content validity of the data obtained from the TAS. Additionally, the reliability coefficients in terms of internal consistency were examined.

3.1. Exploratory factor analysis results of TAS

The results of the exploratory factor analysis conducted with TAS data are shown in Table 1, presenting the explained variance rates and eigenvalues.

Table 1

Eigenvalues and Explained Variance Rates Obtained as a Result of TAS EFA

Variable	Eigenvalue	Proportion of Cumulative Variance (%)	Cumulative Proportion of Variance (%)
1	8.68446	0.57896	0.57896
2	1.54869	0.10325	
3	1.15164	0.07678	
4	0.81550	0.05437	
5	0.58956	0.03930	
6	0.52599	0.03507	
7	0.43441	0.02896	
8	0.34241	0.02283	
9	0.26768	0.01785	
10	0.23745	0.01583	
11	0.18993	0.01266	
12	0.10973	0.00732	
13	0.06509	0.00434	
14	0.03745	0.00250	
15	0.00000	0.00000	

Figure 1

The Scree Plot Showing Eigenvalues for Factor Extraction Based on Exploratory Factor Analysis

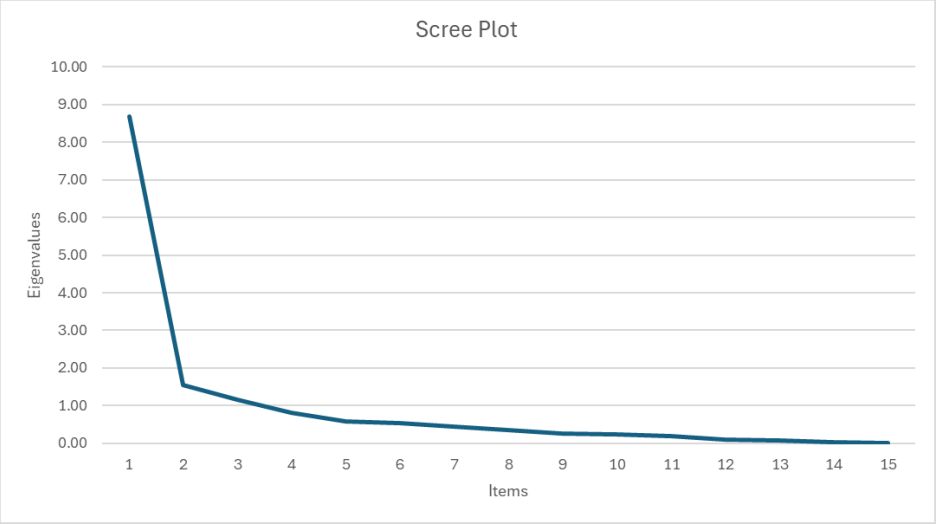


Table 1 shows that the unidimensional structure explains 57.90% of the total variance. Deciding on the number of factors is a challenging step for researchers in exploratory factor analysis (EFA). This need has led to the development of several data-driven methods. In this study, the number of factors was determined using three techniques: parallel analysis (PA) developed by Timmerman and Lorenzo-Seva (2011), the HULL method introduced by Lorenzo-Seva, et al. (2011), and the Minimum Average Partial (MAP) method proposed by Velicer (1976). These methods are reported to provide more accurate results than traditional techniques in determining the number of factors (Ignacio et al., 2006; Kılıç & Uysal, 2019; Liu & Wang, 2016). Therefore, the factor number was determined by triangulating the outcomes of these three approaches.

When examining the explained variance based on eigenvalues in both the HULL and PA analyses, the Cumulative Proportion of Variance values were found to be 0.57896 in both cases. This consistency supports the interpretation that both the PA and HULL methods suggest a unidimensional structure. Given that the single-factor structure accounts for 57.90% of the total variance, it was concluded that the scale structure is unidimensional. This unidimensional scale is referred to as the Teacher Autonomy Scale (TAS) and consists of 15 items. The factor loadings obtained from the EFA are presented in Table 2.

Table 2

The Factor Loadings of TAS

	Item	Factor Loading	Communality
1	The teacher must be able to determine teaching methods/strategies.	0.651	0.424
2	The teacher should be able to determine classroom teaching approaches.	0.688	0.473
3	The teacher must be able to choose appropriate methods and techniques for teaching.	0.795	0.631
4	The teacher should be able to use materials he deems appropriate in teaching.	0.816	0.666
5	The teacher should be able to determine the use of the classroom.	0.774	0.598
6	The teacher must be able to determine the rules of behavior in the classroom.	0.755	0.569

Table 2 (Continued)

7	The teacher should be able to support autonomous student behavior in the lesson.	0.761	0.579
8	The teacher must be able to make changes in the teaching process.	0.704	0.496
9	The teacher should be able to use the measurement and evaluation methods he deems appropriate.	0.704	0.496
10	The teacher should be able to use classroom teaching time freely.	0.644	0.414
11	Teachers should have a primary say in solving problems related to teaching processes.	0.698	0.487
12	Curriculum should be planned primarily by taking teachers' opinions into consideration.	0.853	0.728
13	Teachers should have a primary say in decisions regarding their profession.	0.760	0.577
14	Teachers should be involved in every decision at the school level.	0.828	0.686
15	Teachers should be included in management processes.	0.652	0.424
Total variance explained		0.57896	

When analyzing Table 2, it is evident that the factor loadings range from 0.644 (Item 10) to 0.853 (Item 12). Regarding the minimum acceptable factor loading values, Costello and Osborne (2005) considered a threshold of 0.30 as sufficient, while Tabachnick and Fidell (2019) suggested a minimum value of 0.32. Moreover, considering that the minimum recommended explained variance for a unidimensional structure is at least 30% (Büyüköztürk, 2013), the observed explained variance of 57.896% suggests that the unidimensional factor structure of the scale is statistically adequate and conceptually sound. The Turkish version of the scale is also presented in APPENDIX A.

3.2. TAS reliability analysis results

As a result of the reliability analysis, it was observed that the Cronbach's alpha reliability coefficient of the TAS, indicating internal consistency, was 0.890. The TAS also demonstrated a high level of internal consistency, as evidenced by McDonald's ordinal omega coefficient of 0.947 and the standardized Cronbach's alpha coefficient of 0.947. According to these results, it can be concluded that the internal consistency reliability of the data obtained through TAS is high (Hair et al., 2009).

3.3. Examination of data obtained from TAS in terms of CFA assumptions

Upon examination, it was determined that there was no missing data in the dataset. Multivariate outliers were assessed using Mahalanobis distance, and extreme values were removed accordingly. In SPSS, the significance of the Mahalanobis distance was tested using the 1-Chi-squared (Mahalanobis distance, number of items – 1) formula. As a result, 12 cases with significance at the $\alpha = 0.001$ level were excluded, yielding a dataset of 348 participants. Multicollinearity and singularity issues—defined as excessively high correlations or correlations equal to 1—were examined using condition index (CI), variance inflation factor (VIF), and tolerance values (TV). To avoid multicollinearity, TV should be greater than 0.01, VIF should be less than 10, and CI should be under 30 (Kline, 2016; Tabachnick & Fidell, 2019). In the dataset, the VIF ranged from 1.41 to 2.65, the TV ranged from 0.38 to 0.71, and the CI ranged from 1.00 to 95.51. Although the CI exceeded the threshold, Pearson correlation coefficients were also examined. The correlations ranged from 0.26 to 0.69, indicating that no multicollinearity problem existed among the variables (Tabachnick & Fidell, 2019).

Another assumption of CFA is multivariate normality. This was tested using Mardia's (1970) multivariate skewness coefficient, and the assumption was not met (Skewness coefficient = 5109.44, $p < 0.01$). Therefore, the mean and variance adjusted unweighted least squares (ULSMV) method was used

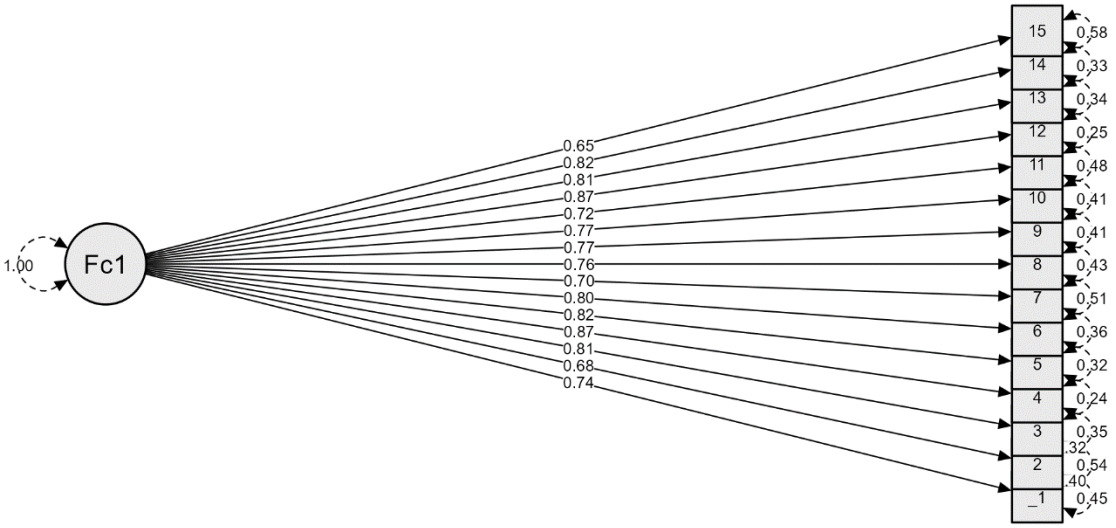
as the estimation technique, which is robust to violations of multivariate normality in categorical data (Brown, 2015; Kılıç & Doğan, 2021). CFA was conducted to test the structural validity of the scale. Because the variables had five categories, a polychoric correlation matrix was used, following the recommendation of Kılıç (2022), who emphasized that polychoric matrices produce less biased estimates for ordinal data. All CFA analyses were conducted using JASP software (JASP Team, 2014).

3.4. Confirmatory factor analysis findings

CFA was performed to confirm the factor structure identified in EFA. Modification indices indicated that correlating the error terms for Items 5 and 6 and for Items 1 and 2 would improve the model fit. This adjustment was justified by the use of similar concepts in those items and the potential for acquiescent responding (Brown, 2015). The results of the CFA suggested that the unidimensional structure provided an acceptable model-data fit: $\chi^2/df = 7109.021$, $p < .01$; RMSEA = 0.096; SRMR = 0.075; CFI = 0.96; TLI = 0.95. An RMSEA value around 0.09 and an SRMR value near 0.08 indicate acceptable fit (Hu & Bentler, 1999; Steiger, 2007). CFI and TLI values of 0.95 or higher indicate a strong model fit (Hu & Bentler, 1999). The final model is illustrated in Figure 2.

Figure 2

The Confirmatory Factor Analysis Model Tested with the TAS



When Figure 2 is examined, it can be said that the factor loadings vary between 0.65-0.87.

3.5. ANOVA and T-test results for teacher autonomy

To examine whether teacher autonomy varies depending on the age, gender and education status ANOVA analysis and t-test were conducted.

Table 3

ANOVA Results for Teacher Autonomy by Seniority Status

	n	x̄	Sd	F	*p*
Teacher Autonomy	348	4.687	.3426	.885	.414
Up to 10 years	110	4.663	.35803		
11-20 years	145	4.715	.34507		
21 and more years	93	4.671	.3199		

*p< .05

When Table 3 is examined, it is concluded that there is no significant difference in the level of teacher autonomy [$F(3, 348)$= .88, p= .414] according to the seniority of the teachers. The primary reason why

there is no significant difference in teacher autonomy between teachers who are in their early years of their profession and those who are senior in their profession can be shown as the centralized structure of the education system. Determination of policies and practices from the center considerably narrows down the autonomy areas of teachers within the school and classroom. The study conducted a t-test analysis to investigate whether teacher autonomy varies by gender. The results obtained are presented in Table 4.

Table 4

T-test Results for Teacher Autonomy by Gender and Education Status

		n	$\bar{x}$	Sd	df	t-Test	p
Gender	Female	232	4.720	.3217	346	2.477	0.01*
	Male	116	4.620	.3735			
Education Status	Undergraduate	255	4.684	.3540	346	-.268	0.78
	Graduate	93	4.695	.3110			

*p<.05

According to the independent sample t-test results, there was a statistical difference between the teacher autonomy scores of female and male teachers [t(346)= 2.47, p<.005]. According to these findings, it was observed that autonomy scores ($\bar{x}_{female}$= 4.72, SD_{female}= .32; $\bar{x}_{male}$= 3.62, SD_{male}= .37) of female teachers were higher than those of males. It is an expected finding that the level of autonomy of female teachers will show a significant difference in this profession, which is mostly preferred by women in Türkiye. In addition, according to the independent sample t-test results, there was no statistical difference between the teacher autonomy scores of undergraduate and graduate teachers [t(346)= -.26, p<.005]. According to this finding, it can be concluded that the level of education does not cause a significant difference in the autonomy of the teacher in the school and classroom.

4. Discussion and Conclusion

This research aimed to conduct a validity and reliability study of the "Teacher Autonomy Scale", which was developed to determine the autonomy levels of teachers in classrooms and schools. As a result of the exploratory factor analysis conducted on the data collected from 198 teachers working in the Küçükçekmece district of Istanbul Province, It was determined that 15 items in the scale had high loading values under a single factor. The factor loadings of the items in the unidimensional structure range from 0.644 and 0.853, explaining common variance ratios between .414 and .728, which were observed to vary. The 15 items in the single-factor scale explain approximately 58% of the total variance. The scale's Cronbach's Alpha internal consistency coefficient was calculated as 0.890.

After this stage, CFA was performed to interpret the model-data fit by the unidimensional factor structure. As a result of CFA, the fit indices results were χ^2/sd = 7109.021 p<0.01, RMSEA=0.112, SRMR = 0.094, CFI= 0.94, and TLI= 0.93. When the scale was examined, it was concluded that the two modifications made in the model fit of the scale were due to the use of similar concepts in the questions and accepting answers (Brown, 2015). After the modifications, the CFA fit index results were found as χ2/sd = 7109.021, p<0.01, RMSEA=0.096, SRMR=0.075, CFI=0.96 and TLI=0.95.

These findings obtained from CFA analyses show that TAS provides construct validity. Based on the findings from both EFA and CFA in this study, it is concluded that the single-factor of the 'Teacher Autonomy Scale' is a reliable, valid, and useful measurement tool. The use of the convenience sampling method and the fact that the data were obtained through an online data collection method can be stated as limitations of the study. In addition, considering the fact that it is not possible to collect data from the same participants again, the lack of content and criterion validity can also be included in the limitations of the study. Considering that measurement tools must not only show validity and reliability but also be practical, it is seen that the developed scale contributes to the literature as an alternative for researchers in terms of usability.

In this study, it was seen that teachers' perceptions of autonomy primarily develop within the framework of teachers' education duties and teaching duties and management duties, and a measurement tool that can measure these elements holistically in a single dimension was developed and presented to the literature (Parcerisa et al., 2022; Worth & Van den Brande, 2020). How each teacher experiences their autonomy can vary according to various variables, and the dimensions of teacher autonomy can also emerge as a government issue in education systems dominated by central administration. In systems where education is managed centrally, teacher autonomy is at risk with the increase in practices such as standardized tests, definition of common learning standards, and determination of how students will be taught and evaluated. However, trust-based regimes with high collective and institutional autonomy mitigate the effects of performative pressures on both teachers' sense of autonomy and their duties (Wermke & Höstfält, 2014). In this study, by examining the forms that define different qualities of teacher autonomy that may emerge in time and space, a scale focused on the teaching and management duties of the teacher was developed without the need for detailed definitions that make teacher autonomy much more complex.

Although the level of teacher autonomy is expected to be limited in centralized education systems, teachers' readiness levels for their current teaching levels should also be high. The effectiveness of positive regulations regarding teacher autonomy in the education system is directly proportional to how ready teachers feel in this regard. It is clear that granting unlimited autonomy to teachers in a system where the majority of teachers are unfamiliar with the concept of autonomy, are not innovative, and are reluctant to take responsibility and authority will not produce beneficial results and will even lead to more negative results (Üzüm, 2014).

Therefore, understanding student teachers' perspectives on the environment they will work in and decision-making processes is important to observe whether they are ready for teacher autonomy (Kartal & Balcıkanlı, 2019). The results of the studies by Pan (2023) and Pearson and Moomaw (2005) show that teachers with more autonomy experience less work-related stress. Teachers are seen as a source of information and an important asset for students in terms of using students' autonomous capacity. For students to progress towards greater autonomy, they need to be supported by autonomous teachers (Ming & Alias, 2007). Teachers themselves need to be autonomous for students to be successful in teaching (Kartal & Balcıkanlı, 2019). As Little (1995) put it: “Successful students have always been autonomous. The same is true of teacher autonomy. Truly successful teachers have always been autonomous in the sense of having a strong sense of personal responsibility for their teaching, exercising the greatest possible degree of emotional and cognitive control of the teaching process through constant reflection and analysis, and exercising the freedom this affords” (p. 179).

Teacher autonomy is multifaceted, depending on the different structural characteristics of countries' education systems, the general conditions of schools, and the personal characteristics of the teacher (Çalışıcı Çelik & Atik, 2020). While developing this scale, which will contribute to the field by making the perception level of teacher autonomy more concrete and simplified, the most basic and concrete duties of teachers were taken as basis. TAS is a valid and reliable scale that can be used to determine the level of autonomy of teachers at every stage of education and in every field of teaching. According to the levels of autonomy of teachers determined in the classroom and throughout the school during the education process, policy makers in the central administration will be able to obtain important findings that will determine new policies regarding the limits of the level of autonomy of teachers. In addition, research conducted on this subject will contribute to teachers questioning their current levels of autonomy while performing their professions, and awareness will develop regarding the necessity of developing and innovative applications regarding the benefits and requirements of the importance of teacher autonomy in terms of school administration.

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Appendix A. Turkish Form of Teacher Autonomy Scale

ÖĞRETMEN ÖZERKLİĞİ ÖLÇEĞİ

Verilen ifadelerden her bir madde için uygun bulduğunuz kutucuğu X ile işaretleyiniz.		Kesinlikle Katılmıyorum (1)	Katılmıyorum (2)	Kararsızım (3)	Katılıyorum (4)	Tamamen Katılıyorum (5)
1	Öğretmen, öğretim yöntemlerini/stratejilerini belirleyebilmelidir.					
2	Öğretmen, sınıf içi öğretim yaklaşımlarını belirleyebilmelidir.					
3	Öğretmen, öğretim için uygun yöntem ve teknikleri seçebilmelidir.					
4	Öğretmen, öğretimde uygun gördüğü materyalleri kullanabilmelidir.					
5	Öğretmen, sınıfın kullanım şeklini belirleyebilmelidir.					
6	Öğretmen, sınıftaki davranış kurallarını belirleyebilmelidir.					
7	Öğretmen, dersteki özerk öğrenci davranışlarını destekleyebilmelidir.					
8	Öğretmen, öğretim sürecinde değişiklik yapabilmelidir.					
9	Öğretmen, uygun gördüğü ölçme ve değerlendirme yöntemlerini kullanabilmelidir.					
10	Öğretmen, sınıf içi öğretim zamanını özgürce kullanabilmelidir.					
11	Öğretim süreçlerine ilişkin sorunların çözümünde öğretmenler öncelikli söz sahibi olmalıdır.					
12	Öğretim programları, öncelikle öğretmen görüşleri dikkate alınarak planlanmalıdır.					
13	Öğretmenler meslekleriyle ilgili kararlar alınırken öncelikli söz sahibi olmalıdır.					
14	Okul düzeyindeki her karara öğretmenler dahil edilmelidir.					
15	Yönetim süreçlerine öğretmenler dahil edilmelidir.					

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Research Article

Attitude Scale Toward Innovation for Primary School Students: Scale Development and Validation

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Abstract: This study aimed to develop a valid and reliable scale to assess the attitudes of primary school students toward innovation. The research was conducted with data from 733 third- and fourth-grade students in the Marmara Region. Designed as a descriptive study, the research employed exploratory and confirmatory factor analyses to evaluate the data. Initially, a literature review examined the concept of innovation and how it could be measured appropriately for children. Based on the findings, a pool of 44 items was created using a five-point Likert scale (ranging from strongly disagree to agree strongly). After expert reviews and a pilot study, this pool was refined to 38 items. The exploratory factor analysis results indicated that the scale consisted of four factors: Curiosity, Self-Confidence, Alternative Usage, and Creativity. These factors accounted for 55.66% of the total variance. Each factor included three items, with factor loadings exceeding 0.30, which supported the construct validity of the scale. The confirmatory factor analysis revealed that the model demonstrated excellent goodness-of-fit values. Findings from the second-order CFA confirmed the relationship between the factors and innovation and showed an excellent fit. As a result, this study developed a valid and reliable instrument for measuring the attitudes of primary school students toward innovation. The scale is anticipated to help understand students' tendencies toward innovative thinking, develop strategies to enhance these tendencies, and evaluate innovation-focused educational programs.

Keywords: Innovation, Primary School Students, Scale Development

1. Introduction

Economist and policy scientist Joseph Schumpeter first defined innovation as “the driving force of development” (Elçi & Karataylı, 2008). Innovation has recently become a significant factor in international competition among countries (Yalçıntaş Gülbaş, 2011). In the contemporary competitive landscape, fostering innovation is among the critical priorities for nations striving to achieve sustainable economic growth and development (Yılmaz & İncekaş, 2018). Economically strong countries are innovation-driven, driven by innovation, while weak economies are factor-driven, based on natural resource wealth (Işık & Kılınç, 2012). Economic power comes from intensive investment and development in concepts such as diversity, creativity, innovation, and R&D. In countries lagging in competition, it is evident that the concept of innovation has not yet been fully understood (Yılmaz & İncekaş, 2018).

Over the past century, the term innovation has gained significance, and numerous definitions focusing on different aspects of innovation have emerged over time. In 1911, Schumpeter conceptualized innovation as the introduction of a previously unknown product to consumers or the enhancement of an existing product’s quality in the market. Additionally, he defined innovation as the adoption of a novel production method, the expansion into a new market, the identification of a new source of raw materials or semi-finished goods, or the restructuring of an industry (as cited in Elçi & Karataylı, 2008). Pierce and Delbecq (1977) defined innovation as initiating, adopting, and implementing new ideas or activities within an organizational context. Damiano (2011) defined innovation as introducing products, processes, or services that are novel for the firm, the market, or the global context. Örtlek (2015) described innovation in its most comprehensive form as transforming knowledge into products, processes, services, and systems facilitated by influential factors such as skilled labor, knowledge, and infrastructure. According to Boak (2022), innovation is the process of generating new and effective

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ideas and making them technically and commercially viable, or introducing new and improved ways of performing tasks. An examination of the definitions in chronological order reveals that the meaning of innovation has shifted over time from a theoretical and commercial perspective to concepts of newness, novelty, and methods of renewal over time. Similarly, in the TDK dictionary (2024), the word "innovation" is listed as synonymous with "renewal", which is defined as "the introduction of new methods in social, cultural, and administrative contexts to adapt to changing conditions."

Innovation is associated with phenomena such as creativity, entrepreneurship, commercialization, learning, and invention, and conceptual clarification is needed to better understand and advance innovation in practice (Klausen, 2017). Innovation is often regarded as synonymous with creativity and is particularly used as a substitute for the term creativity in the field of sociology. However, while these two concepts are closely related, they are not entirely identical. The realization of innovation requires a creative process; however, not every creative process must necessarily result in or be transformed into economic value (Keleşoğlu & Kalaycı, 2017). Although innovation does not fully correspond to the term "novelty," it is fundamentally a process of novelty. However, not every novelty is considered innovation; the essence of innovation lies in its aim to generate economic or social benefit. Since it encompasses the concept of novelty, innovation is often confused with inventions. However, innovation does not mean making an invention, although it is possible to utilize inventions within the innovation process (Taş, 2017). Creativity and innovation are inseparable components of the same process; while research on creativity focuses on idea generation, studies on innovation concentrate on the implementation of those ideas (Anderson et al., 2014). Innovation is more than creativity or technology; it requires the transformation of ideas into practical, implementable products, services, processes, or business models (Taylor, 2017).

Innovation enhances economic growth, job creation, and quality of life by increasing productivity and competitiveness. It enables efficient use of resources, turning them into valuable products and services, thus improving overall societal welfare (Çeliktaş, 2008). Innovation is a process composed of successive stages, beginning with the development of new ideas through research. Inspiration and imagination play a critical role in the emergence of new ideas as the innovation process advances through the shaping of creative ideas and their realization as practical, implementable solutions (Ahmed & Abdalla, 1999).

Drucker (1998) identified seven sources of innovation, four of which are internal and three external. These sources include unexpected events (successes or failures), process needs, changes in industry and market structures, economic or process incongruities, demographic shifts, shifts in perception, and the generation of new knowledge. Eurostat and OECD (2005) categorize innovation into four main types: product, process, marketing, and organizational. Product innovation refers to the introduction of new or significantly improved goods or services in terms of technical specifications, materials, usability, or other functional features. It may rely on new technologies or novel combinations of existing knowledge (Eurostat, n.d.-c). Process innovation involves the implementation of significantly improved production or delivery methods, including changes in techniques, equipment, or software, aimed at reducing costs or enhancing quality (Eurostat, n.d.-a). Marketing innovation is defined as the application of a new marketing method that entails substantial changes in product design, packaging, promotion, placement, or pricing. Such innovations aim to better meet customer needs, open new markets, or reposition products (Eurostat, n.d.-d). Lastly, organizational innovation encompasses the adoption of new methods in business practices, workplace organization, or external relations to improve performance, reduce costs, or enhance knowledge flow. These methods must be new to the firm and the result of deliberate strategic decisions (Eurostat, n.d.-b).

One of the most critical factors for the success of an innovation is establishing an innovation-oriented culture and structure (Akyos, 2007). The cultural structure of societies profoundly influences innovation, and innovative actions are more likely to occur in societies with an innovative culture

(Muthukrishna & Henrich, 2016). Fostering an innovation-oriented culture places significant responsibility on education systems. One of the key factors in the success of development and innovative activities is the human capital that societies possess. Education must be the primary focus to cultivate a skilled workforce (Yılmaz & İncekaş, 2018). Innovation is a process that can emerge in various forms across many areas of society. Numerous countries have successfully implemented this process, reaping economic and social benefits. Innovation has accounted for 66–75% of labor productivity growth in developed countries through multi-factor productivity gains. (OECD, 2010). Achieving such success requires globally aware individuals, willing to take risks, creative, inquisitive, highly communicative, collaborative, and productive (Taş, 2017). In this context, innovation can be regarded as the product of a culture that embraces novelty, welcomes change, and embodies an entrepreneurial spirit (Örtlek, 2015).

Education is widely recognized as a critical enabler of innovation and economic growth (Brennan et al., 2014). Policies aimed at expanding educational access, enhancing quality, and investing in higher education institutions have the potential to foster innovation at both individual and societal levels (Biasi et al., 2021). Beyond increasing participation rates, the quality of education plays a decisive role in driving technological advancement, as evidenced by its correlation with patent-based innovation metrics (Fernández-Rodríguez Labordeta & Giménez, 2012). Educational processes contribute to innovation by equipping individuals with essential competencies such as communication, collaboration, and problem-solving skills (Leiponen, 1996). Furthermore, innovations within the educational domain—such as the integration of digital technologies, personalized learning models, and inclusive pedagogical practices—support students in becoming critical thinkers and autonomous learners (Rabinowitz & Miles, 1965). At the entrepreneurial level, innovation is positively influenced by educational attainment, targeted training, supportive policy environments, and cultural values that emphasize individualism (Hovne et al., 2014). In this context, a shift in formal education is required to prioritize the development of soft skills and to promote lifelong learning as foundational elements of an innovation-oriented education system (Cobo, 2013).

Innovation relates to designing educational environments that equip individuals with the skills needed for both today and the future while aligning teaching and learning processes with the needs of society and the economy (Taş, 2017). Education is recognized as one of the fundamental components of innovation and is featured in the annually published Global Innovation Index. Education is considered one of the fundamental elements of innovation and holds a prominent place in the index (Dutta et al., 2024). The education component is calculated based on factors such as national education expenditure, public spending per student, expected years of schooling, PISA scores in reading, mathematics, and science, and the student-teacher ratio (TİM, 2022). In the Global Innovation Index 2024 Report, Turkey has risen to third place among upper-middle-income countries but remains 37th in the overall ranking (Dutta et al., 2024). Therefore, to transform our country into a more innovation-driven nation, it is crucial to cultivate generations equipped with the culture, knowledge, and skills necessary for innovation.

In the context of this study, innovation is conceptualized as a multidimensional construct encompassing curiosity, self-confidence, alternative usage, and creativity. These dimensions are drawn from a synthesis of existing literature and adapted to the developmental and cognitive characteristics of elementary school students. Curiosity, as a fundamental cognitive driver, propels scientific discovery and underpins innovation by fostering a desire to explore the unknown (Kuo, 2019; Nowotny, 2008). It is closely intertwined with creativity through their shared novelty-seeking basis, which is shaped by an individual's mental state (Ivancovsky et al., 2023). However, curiosity tends to decline as students progress through formal education (Stokoe, 2012), making it critical to support and assess it from early schooling. Self-confidence, particularly in the form of creative self-efficacy, is another foundational

aspect influencing innovation. It mediates how learners perceive challenges and their capacity to generate novel solutions (Acar et al., 2018; Chong & Ma, 2010). Alternative usage, or the ability to assign new functions or domains to existing products and ideas, represents a practical manifestation of innovative thinking (Boak, 2022; Damiano, 2011). This dimension reflects Schumpeter's (1911) view that innovation need not always involve new inventions but can emerge through novel applications of what already exists. Lastly, creativity serves as both a precursor and catalyst for innovation, facilitating the development and transformation of ideas into tangible outputs (Cropley, 2006; Patil, 2024). Nevertheless, creativity alone is insufficient without contexts that nurture and channel it toward productive outcomes (Nayak & Agarwal, 2011). In educational environments, these four dimensions are not only interrelated but also form the cognitive and emotional basis upon which innovation readiness is built. Therefore, integrating and assessing these constructs in elementary education is essential for cultivating students' long-term capacity for innovation.

An examination of the Turkey Century Education Model (MEB, 2024) reveals that learning outcomes directly related to innovation are introduced into the curriculum starting from the 6th grade. However, the overall structure of the program frequently emphasizes competencies that are closely associated with innovation, such as product design and creation skills, entrepreneurial abilities, reasoning, and scientific inquiry. Additionally, the model promotes the development of individuals who are productive, inquisitive, and creative, with a strong focus on cultivating literacy skills that enable adaptation to new situations and sensitivity to change. In this regard, it is anticipated that these competencies and qualifications will play a significant role in foregrounding innovation within educational contexts in the future.

A review of the literature on innovation reveals a significant number of studies focusing on schools and innovation (Çayak & Erol, 2022; Ergöz et al., 2023), teachers' levels of innovation across various variables (Fidan, 2019; Gökbulut, 2021; Özer, 2022; Özerdem & Serin, 2022; Yüner & Özdemir, 2020), school administrators' perceptions and views on innovation (Erdemet, 2017; Sarıçan, 2018), program development efforts aimed at training innovative teachers (Akdeniz, 2020), and school administrators' competencies in innovation (Bayrakçı & Erarslan, 2014; Eren et al., 2024; Özerdem & Serin, 2022). These studies highlight the critical role of key educational stakeholders, including school administrators and teachers, in fostering innovation. However, a literature review indicates that studies focusing on students and innovation are limited. Existing studies include research on the innovative thinking tendencies of middle school students (Deveci & Kavak, 2020), attitudes toward innovative thinking (Gedik & Demirezen, 2023), the innovation levels of 7th-grade students (Akkaya, 2016), and the effects of innovation project applications aimed at 6th-grade students (Kavacık et al., 2015). In the literature, there are measurement tools designed to assess individual innovation competencies in adults (Kılıçer & Odabaşı, 2010; Naillioğlu Kaymak et al., 2022; Ovacı & Yıldırım Saatçi, 2020; Sarıoğlu, 2014) and innovation skills among youth (Altınışık et al., 2023).

A review of studies related to innovation in primary schools reveals a considerable focus on innovative educational models (Carless, 2004; Hornstra et al., 2015; Leoste et al., 2021; Zhang et al., 2011) and the integration of innovation into primary education (Attema-Noordewier et al., 2012; Heißenberger, 2016; Pollock, 2008). However, there appears to be a limited number of studies specifically aimed at fostering innovation development among primary school students. The literature includes research on the development of instructional models to support creativity and innovation at the primary level (Likar et al., 2014), as well as findings indicating that makerspaces in primary schools enhance students' motivation toward innovation (Leskinen et al., 2023). Additionally, it has been observed that innovation is frequently addressed within the framework of 21st-century skills in studies focusing on children in primary education (Chalkiadaki, 2018; Chu et al., 2012; Soderlund, 2020) and that efforts have been made to assess innovation-related competencies within the broader framework of 21st-century skills at

the primary education level (Boyacı & Atalay, 2016). However, a review of the literature indicates that no appropriate measurement tools for assessing innovation-related attitudes among elementary school children have been encountered.

Integrating innovation into education has become a critical priority in today's rapidly evolving knowledge economy. Education must adopt innovation as a fundamental principle of pedagogy, preparing students not only to adapt to the current world but also to shape the challenges and opportunities of the modern era (Sawyer, 2006). Innovation education at the primary school level is a strategic and socially responsible investment that supports both individual development and long-term societal progress. As highlighted by Likar et al. (2014), promoting creativity and innovation should begin in early education, when students are most receptive to cultivating curiosity, critical thinking, and initiative. Therefore, equipping children with attitudes and dispositions related to innovation from a young age is essential for building future-ready, adaptive learners who can contribute meaningfully to their communities. For this reason, this study aims to develop a measurement tool to evaluate elementary school students' attitudes toward innovation.

2. Method

A descriptive research design was employed in this study, which aims to develop a measurement tool to assess elementary school students' attitudes toward innovation. Descriptive research seeks to identify and carefully describe a given phenomenon as it exists (Büyüköztürk et al., 2020, p. 24).

2.1. Study group

The research was conducted during the 2024-2025 academic year. The study group consists of 3rd and 4th-grade primary school students. In forming the study group, convenience sampling was employed. Convenience sampling is a non-probability sampling method in which participants are selected based on their accessibility and proximity to the researcher, rather than through random procedures (Baltacı, 2018). Accordingly, the participants of the study were chosen from among students who were readily accessible to the researchers during the data collection process. The inclusion of both 3rd and 4th-grade students was a deliberate methodological choice grounded in developmental and educational theory. These grade levels represent a transitional phase in which children's metacognitive awareness, self-regulatory abilities, and strategic thinking begin to consolidate and become more consciously accessible (Flavell, 1979; Kuhn, 2000). Research shows that while the early signs of metacognitive processes appear in preschool and the early grades, their functional and observable use in academic contexts becomes more prominent between the ages of 8 and 10, which generally corresponds to 3rd and 4th grades (Kuhn, 2000). Therefore, these two grades were specifically selected, rather than 1st or 2nd grade, as they reflect a developmental stage in which students are more likely to articulate their thoughts, reflect on their learning processes, and respond meaningfully to measurement instruments designed to capture cognitive and behavioral tendencies (Alexander et al., 2001).

The study group consisted of 733 third and fourth-grade students enrolled in three different public schools in a central district of the Marmara region. The prepared item pool was administered to 765 students; however, 32 responses were excluded from the study due to issues such as incomplete or improperly filled data.

Table 1

Demographic Information of the Participant Group

Gender	3rd Grade	4th Grade	Total
Female	167	219	386
Male	161	226	387
Total	328	445	773

An analysis of Table 1 reveals the demographic information of the participant group. Of the study group, 42.43% are 3rd-grade students, while 57.56% are 4th-grade students. Also, 49.93% of the study group consists of female students, while 50.07% are male students. The collected data was organized and transferred into a statistical analysis software. The collected data were divided into two subsets during the data analysis phase. 301 data were used in exploratory factor analysis, and 472 data were used in confirmatory factor analysis.

2.2. Scale development progress

In developing the Attitude Scale Toward Innovation for Elementary School Students, the 8-step framework proposed by DeVellis (2022) was utilized. The procedures carried out within these steps are presented below;

Since the study aims to measure elementary school students' attitudes toward innovation, the process began with a comprehensive review of the literature on the concept of innovation. At this stage, definitions of the concept of innovation provided by different researchers and studies on measuring innovation in children were reviewed in the literature. As a result of this process, the structure of how innovation may manifest in children and how it could be identified was determined. Following this, the development of an item pool commenced.

During the creation of the item pool, concepts related to innovation, expressions found in the definitions, studies focused on measuring innovation in adults, and the indicators of innovation self-efficacy developed by Gerber et al. (2012) were examined. Based on the reviewed studies, a list of indicators specific to children was created, and child-appropriate expressions were written for these indicators to form the item pool. During this process, the written items were discussed with children at an elementary school under the guidance of the researcher. The children's understanding of the items and whether the items were interpreted correctly were carefully examined.

The relevant literature was reviewed at the step of determining the measurement scale. An analysis of scales developed for elementary school students revealed several examples utilizing 3-point Likert scales (Kaya & İzci, 2024), 4-point Likert scales (Alkış Küçükaydın et al., 2024), and 5-point Likert scales (Toma, 2021). Mellor and Moore (2013) noted that 5-point Likert scales are developmentally appropriate for children aged 8 years and older, as they are capable of distinguishing between more nuanced response options. Massey (2021) found that the addition of emojis to Likert-type response formats improved young children's understanding of response categories and increased their ability to accurately express emotional attitudes, especially in survey contexts requiring affective judgment. In addition to the literature, expert consultation was sought from an expert in educational measurement and evaluation regarding scale structure and age appropriateness. Based on these findings and expert input, a 5-point Likert scale was adopted, and emojis ranging from a crying face to a smiling face were placed beneath each response option to enhance comprehensibility.

An expert review form was developed along with the prepared item pool and Likert structure. The expert review form was designed using the Lawshe (1975) technique. The form began with an explanation of the purpose of the scale development study, details about the target sample, and ethical considerations. During the feedback process, the first column of the expert review form listed the scale items, while the adjacent columns included checkboxes labeled "appropriate," "needs revision," and "should be removed." The far-right column allowed experts to write specific feedback on each item. The expert review form was sent to three primary school field experts, containing the initial draft item pool of 42 items. Based on the feedback received from these experts, several items were revised or removed from the scale. Additionally, in light of the feedback received from the experts, new items were added, resulting in a second draft item pool consisting of 44 items. This second draft item pool was then sent to an education measurement and evaluation expert and an expert in the field of educational sciences

who has previously developed an innovation scale. For example, as expert opinions, the item *"I feel happy when the things I make work"* included in the draft item pool was removed following the feedback of a primary education expert, who noted that *"if the student has not made anything, they will not be able to respond to this item."* Similarly, the item *"I listen to others' opinions when making my own decisions"* was excluded from the form based on the suggestion of another expert in primary education, who indicated that more appropriate items could be included under the relevant factor. Moreover, considering the opinion provided by a measurement and evaluation expert stating that *"the verb 'want' may not adequately reflect emotional states, so it is preferable to use verbs that directly express emotions, such as 'like'"*, the verbs used in the form were revised. Additionally, considering the view of an educational sciences expert who had previously developed an innovation scale—asserting that *"innovation is a process related to transformation,"* the existing items were revised, and items such as *"I transform broken toys into new ones"* were added to the item pool. Following their recommendations for revisions, a final item pool of 38 items, ready for pilot testing, was developed.

Data analysis was conducted using statistical analysis software to evaluate the items and adjust the scale length. In the data analysis phase, the normality of the distribution was first examined. In literature, skewness and kurtosis values between +1.5 and -1.5 (Tabachnick & Fidell, 2013) or +2.0 and -2.0 (George & Mallery, 2010) indicate a normal distribution. The entire dataset was divided into two subsets for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Both datasets fell within the specified range of values, indicating normal distribution. Following this step, exploratory factor analysis (EFA) was conducted.

The Kaiser-Meyer-Olkin (KMO) test for sampling adequacy was first examined in the EFA. The KMO test was performed to determine whether the sample was adequate to represent the population and suitable for factor analysis. The results of the KMO test are presented in Table 2.

Table 2

KMO Test Result

KMO Test	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.787
Bartlett's Test Chi-Square Value	500.178
Bartlett's Test Degrees of Freedom	66
Bartlett's Test p	.000

When Table 2 is examined, the KMO value is 0.787. According to this value, the sample size is adequate for proceeding with factor analysis and reasonably represents the population (Hutcheson & Sofroniou, 1999). The dataset's compliance with the multivariate assumption was assessed using Bartlett's Test of Sphericity. The obtained value indicates that the dataset meets the assumption of multivariate normality *($\chi^2 = 500.178; p < 0.01$).*

In addition to these assumptions, the issue of multicollinearity among variables was examined using Pearson's Product-Moment Correlation, and it was determined that no multicollinearity was present. To determine the construct validity of the scale, principal component analysis (PCA) followed by the Varimax orthogonal rotation method was applied during the exploratory factor analysis (EFA). During the PCA, factors with eigenvalues greater than one were considered, and items with factor loadings of at least 0.32 (Tabachnick & Fidell, 2003) were selected for inclusion in the final scale.

First-order and second-order confirmatory factor analysis (CFA) methods were applied to validate the structure of the scale. This stage involves testing the measurement model. This process examined whether the factorized structure obtained from principal component analysis could be validated as a model.

3. Findings

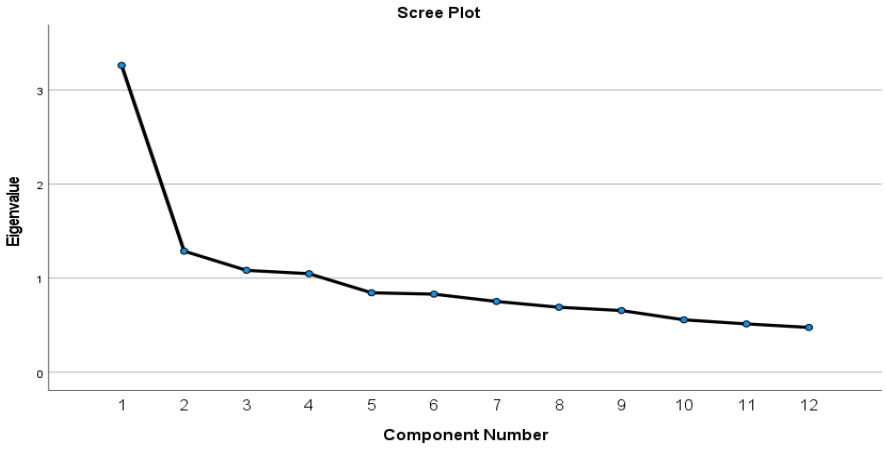
This section presents the results related to the Attitude Scale Toward Innovation for Elementary School Students, including the model developed through exploratory factor analysis, the results of the first-order confirmatory factor analysis conducted on the developed model, and the results of the second-order confirmatory factor analysis, which tested the unification of the model validated in the first-order analysis under the innovation factor.

3.1. Findings Related to Exploratory Factor Analysis (EFA)

Exploratory factor analysis (EFA) was utilized to identify the underlying factors of the observed variables in the dataset. During the EFA process, principal component analysis was used. The Varimax orthogonal rotation method was applied to make the factor structure more meaningful and interpretable. The final analysis revealed that the scale has a four-factor structure with eigenvalues greater than 1.00. The scree plot of the eigenvalues for the scale is presented in Figure 1.

Figure 1

Eigenvalue Analysis for the Attitude Scale Toward Innovation for Elementary School Students



When Figure 1 is examined, it is observed that the inflection point begins after the fourth factor. In the eigenvalue scree plot, sharp and distinct drops are considered a critical criterion in determining the number of factors (Büyüköztürk, 2021). This finding supports the conclusion that the scale consists of a four-factor structure. The factors comprising the scale and the total variance explained by these factors are presented in Table 3.

Table 3

Factors, Eigenvalues, and Explained Variance of the Attitude Scale Toward Innovation for Elementary School Students

Factor	Eigenvalues	Explained Variance	Cumulative %
1	3.262	27.182	27.182
2	1.288	10.730	37.911
3	1.183	9.024	46.935
4	1.047	8.728	55.663

When Table 3 is examined, it is observed that the four factors constituting the scale explain 55.66% of the total variance. The first factor explains 27.18%, the second factor 10.73%, the third factor 9.02%, and the fourth factor 8.72% of the variance. The items forming each factor were analyzed, and based on their contextual meaning, the factors were named in alignment with the literature. The names of the factors and their respective items are presented in Table 4.

Table 4

Naming of the Factors in the Attitude Scale Toward Innovation for Elementary School Students

Factor	Number of Items	Item Numbers
Curiosity (Factor 1)	3	15.16.17
Self-Confidence (Factor 2)	3	3.5.23
Alternative Usage (Factor 3)	3	18.19.20
Creativity (Factor 4)	3	2.7.10

Table 4 presents the factors identified in the Attitude Scale Toward Innovation for Elementary School Students. The scale consists of four factors: Curiosity, Self-Confidence, Alternative Usage, and Creativity. Each factor comprises three items.

Table 5

Items and Factor Loadings of the Attitude Scale Toward Innovation for Elementary School Students

	1 Curiosity	2 Self-Confidence	3 Alternative Usage	4 Creativity
16- I observe what is happening around me.	.758			
17- I ask questions about topics I am curious about.	.660			
15- When I see something new, I scrutinize it.	.629			
23- I do not give up when encountering difficulties while creating something new.		.811		
5- I do not give up until I achieve my dreams.		.754		
3- I am confident in my ability to create new things.		.408		
19- I transform broken toys into new ones.			.771	
18- I enjoy creating new things from waste materials.			.708	
20- I like making new toys for myself from different materials.			.614	
2- I like activities that require using my imagination.				.307
7- I want to invent new things.				.801
10-I enjoy lessons where I can invent new things.				.766

Note: The scale was developed in Turkish, and the translation was carried out by the researchers.

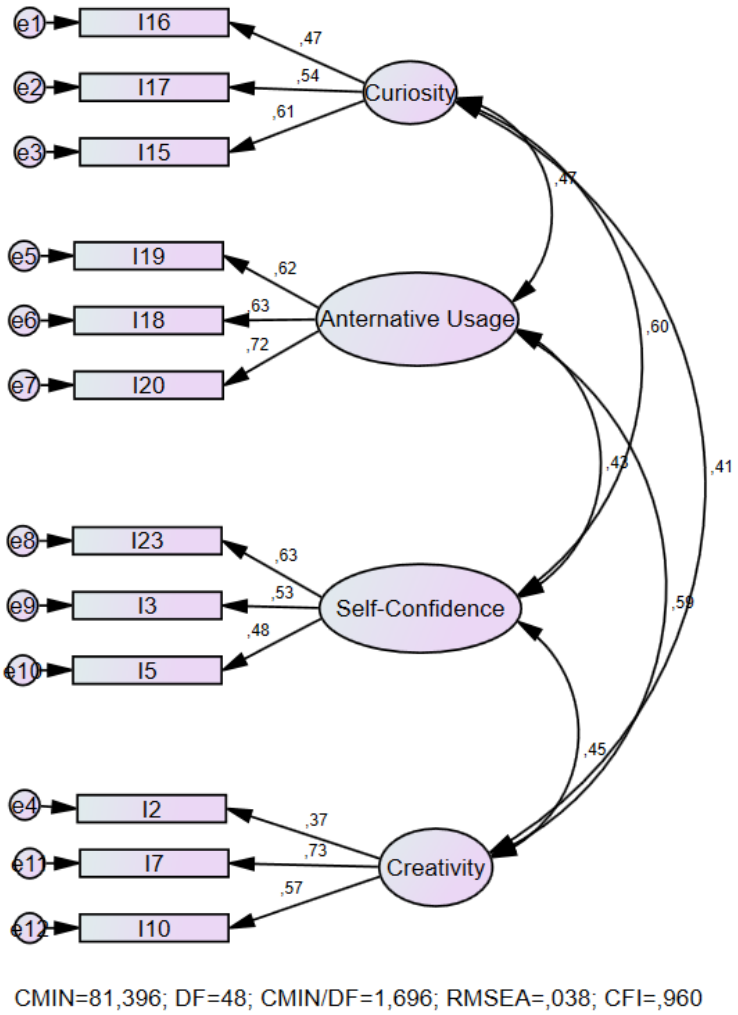
When Table 5 is examined, it is observed that the items grouped under the four factors have factor loadings greater than 0.30, which are considered acceptable values (Büyüköztürk, 2021). This indicates that the items are strongly associated with their respective factors. The items in the Curiosity subdimension aim to evaluate the child's interest in their surroundings, attentiveness, observational skills, and sense of curiosity. The items grouped under the Self-Confidence subdimension are designed to assess the child's motivation to overcome challenges, handle difficulties, and pursue their dreams. The items in the Alternative Usage subdimension measure the child's tendency to create new things using similar or different materials and their interest in this process. The items in the Creativity subdimension aim to measure the child's enjoyment of using their imagination, their willingness to engage in imaginative activities, and their preference for environments that allow them to showcase this ability.

3.2. Findings Related to Confirmatory Factor Analysis (CFA)

Following the EFA, first-order CFA was conducted to determine whether the four-factor structure of the scale could be validated. The results of the first-order CFA for the Attitude Scale Toward Innovation for Elementary School Students, consisting of four factors and 12 items, are presented in Figure 2.

Figure 2

First-Order CFA Model for the Attitude Scale Toward Innovation for Elementary School Students



When the first-order CFA results in Figure 2 are examined, it is observed that the factor loadings of the items range between 0.37 and 0.73. Factor loadings above 0.30 indicate a strong relationship between the item and its corresponding factor (Harrington, 2009). The goodness-of-fit indices for the model are presented in Table 6.

Table 6

Goodness-of-Fit Indices Calculated for the First-Order CFA of the Attitude Scale Toward Innovation for Elementary School Students

X2/sd	P	RMSEA	CFI	GFI	IFI	AGFI
1.696 Perfect Fit*	.002	0.038 Perfect Fit*	0.960 Perfect Fit*	0.972 Perfect Fit*	0.960 Perfect Fit*	.954 Perfect Fit*

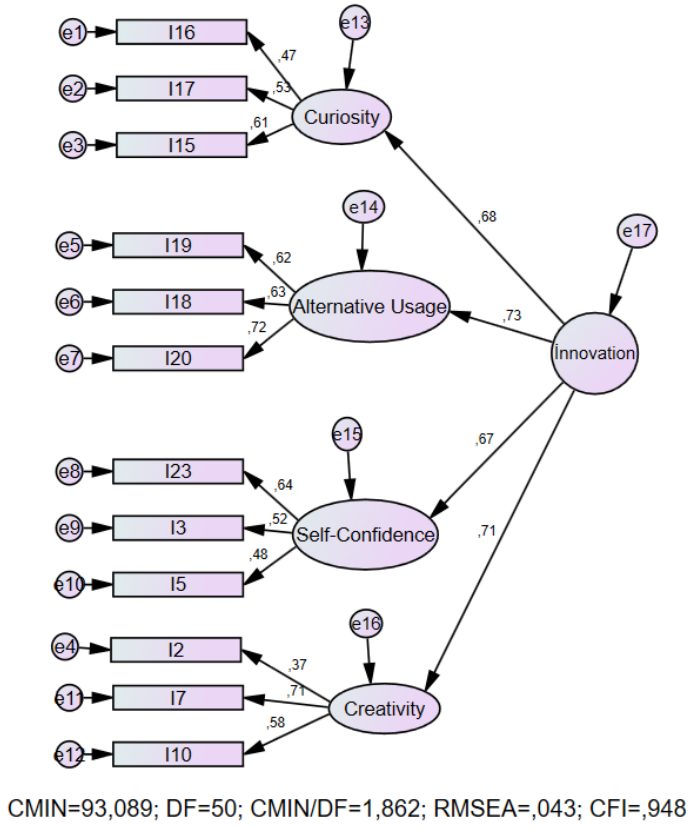
*(Hu & Bentler, 1999)

When Table 6 is examined, as a result of the first-order CFA, the chi-square value for the model of the Attitude Scale Toward Innovation for Elementary School Students is χ^2 = 81.396, with degrees of freedom df = 48, and χ^2/df = 1.696 Examining the fit indices, it is observed that the values are as follows: RMSEA = 0.03, CFI = 0.96, GFI = 0.97, IFI = 0.96, and AGFI = 0.95. Since the χ^2/df value is below 2, the RMSEA value is less than 0.05, and the CFI, GFI, IFI, and AGFI values are greater than 0.95, the model can be described as having a perfect fit.

The multidimensional structure of the Primary School Students' Attitudes Towards Innovation Scale was determined as a latent variable and tested with the second-level multifactor model. The results of the second-order CFA for this model are presented in Figure 3.

Figure 3

Second-Order CFA Model for the Attitude Scale Toward Innovation for Elementary School Students



CMIN=93,089; DF=50; CMIN/DF=1,862; RMSEA=,043; CFI=,948

When the second-order CFA results in Figure 3 are examined, the item's factor loadings range between 0.37 and 0.72. Additionally, the factors related to innovation range between 0.67 and 0.73. The goodness-of-fit indices for the second-order CFA model are presented in Table 7.

Table 7

Goodness-of-Fit Indices Calculated for the Second-Order CFA of the Attitude Scale Toward Innovation for Elementary School Students

X2/sd	P	RMSEA	CFI	GFI	IFI	AGFI
1.862	.000	0.043	0.948	0.968	0.949	.950
Perfect Fit*		Perfect Fit*	Good Fit*	Perfect Fit*	Good Fit*	Perfect Fit*

*(Hu & Bentler, 1999)

When Table 9 is examined, as a result of the second-order CFA, the chi-square value for the model of the Attitude Scale Toward Innovation for Elementary School Students is χ^2 = 93.089, with degrees of freedom df = 50, and χ^2/df = 1.862. Fit indices values are as follows: RMSEA = 0.04, CFI = 0.94, GFI = 0.96, IFI = 0.94, and AGFI = 0.95. Given that the χ^2/df value is below 2, the RMSEA value is less than 0.05, and the CFI, GFI, IFI, and AGFI values are at or above the 0.95 threshold, the model can be described as having a perfect fit.

3.3. Findings related to scale reliability

The reliability of the Attitude Scale Toward Innovation for Elementary School Students has been tested through multiple analyses. McDonald's Omega coefficient analysis was conducted to assess internal

consistency, and a correlation matrix was generated to examine the relationships among factors. Moreover, an independent samples t-test was applied to examine the scale's effectiveness in differentiating between participants with high and low scores. Finally, a test-retest reliability analysis was carried out to evaluate its stability over time.

Table 8

McDonalds Omega coefficient of the Attitude Scale Toward Innovation for Elementary School Students

Factor	McDonald omega (ω)
Scale Overall	.854
Curiosity (Factor 1)	.701
Self-Confidence (Factor 2)	.739
Alternative Usage (Factor 3)	.737
Creativity (Factor 4)	.706

For internal consistency, McDonald's Omega coefficient values for the scale overall and for each of the factors were calculated. The results indicate that the overall scale exhibits a high level of reliability (ω = .854), suggesting that the instrument provides a consistent measurement of students' attitudes toward innovation. Among the factors, the highest internal consistency was observed for the Self-Confidence factor (ω = .739), followed closely by Alternative Usage (ω = .737) and Creativity (ω = .706). The Curiosity factor demonstrated the lowest, yet still acceptable, reliability (ω = .701).

Table 9

Correlation Matrix of the Attitude Scale Toward Innovation for Elementary School Students

Factors		Curiosity (Factor 1)	Confidence (Factor 2)	Alternative Usage (Factor 3)	Creativity (Factor 4)	Scale Overall
Curiosity (Factor 1)	r	1				
Self-Confidence (Factor 2)	r	.588**	1			
Alternative Usage (Factor 3)	r	.394**	.421**	1		
Creativity (Factor 4)	r	.544**	.535**	.463**	1	
Scale Overall	r	.777**	.790**	.768**	.802**	1

*** p<.01*

Table 9 presents the correlation matrix for the Attitude Scale Toward Innovation for Elementary School Students. The correlation coefficients (r) indicate statistically significant relationships among the factors (p < .01). Specifically, Curiosity (Factor 1) demonstrates a moderate positive correlation with Self-Confidence (r = .588) and Creativity (r = .544), while exhibiting a lower yet significant correlation with Alternative Usage (r = .394). Self-Confidence (Factor 2) is moderately correlated with Alternative Usage (r = .421) and Creativity (r = .535). Similarly, Alternative Usage (Factor 3) shows a moderate correlation with Creativity (r = .463). The correlation values between each factor and the overall scale are notably high, indicating strong internal consistency. Creativity (Factor 4) exhibits the highest correlation with the overall scale (r = .802), followed closely by Self-Confidence (r = .790), Curiosity (r = .777), and Alternative Usage (r = .768). These findings suggest that all four factors contribute at a moderate to high level (Çokluk et al., 2012) to the overall construct of innovation attitude in elementary school students.

Table 10

Independent Group T-Test Results based on the Lower-Upper Group Variable

Factor	Group	N	Mean	sd	t	sd	p
Curiosity (Factor 1)	The Upper %27 Group	80	14.46	.50	22.04	158	0.00
	The Lower %27 Group	80	9.30	2.0			
Self-Confidence (Factor 2)	The Upper %27 Group	80	14.73	.44	17.99	158	0.00
	The Lower %27 Group	80	9.62	2.50			
Alternative Usage (Factor 3)	The Upper %27 Group	80	14.31	.73	17.26	158	0.00
	The Lower %27 Group	80	9.42	2.42			
Creativity (Factor 4)	The Upper %27 Group	80	14.86	.34	22.41	158	0.00
	The Lower %27 Group	80	9.17	2.24			
Scale Overall	The Upper %27 Group	80	56.36	1.87	21.29	158	0.00
	The Lower %27 Group	80	37.98	7.48			

Table 10 presents the results of the independent samples t-test conducted to compare the upper 27% group and the lower 27% group in terms of their scores on the Attitude Scale Toward Innovation for Elementary School Students. The findings indicate statistically significant differences *(p < .001)* across all factors and the overall scale. The mean score for Curiosity (Factor 1) was higher in the upper 27% group (M = 14.46, SD = 0.50) compared to the lower 27% group (M = 9.30, SD = 2.00), yielding a significant t-value ($t(158) = 22.04$, $p < .001$). Similarly, Self-Confidence (Factor 2) showed a significant difference between the upper 27% group (M = 14.73, SD = 0.44) and the lower 27% group (M = 9.62, SD = 2.50), with $t(158) = 17.99$, $p < .001$. For Alternative Usage (Factor 3), the upper 27% group (M = 14.31, SD = 0.73) scored significantly higher than the lower 27% group (M = 9.42, SD = 2.42), $t(158) = 17.26$, $p < .001$. A similar trend was observed in Creativity (Factor 4), where the upper 27% group (M = 14.86, SD = 0.34) outperformed the lower 27% group (M = 9.17, SD = 2.24), $t(158) = 22.41$, $p < .001$. The overall scale score also indicated a significant difference, with the upper 27% group (M = 56.36, SD = 1.87) scoring higher than the lower 27% group, $t(158) = 21.29$, $p < .001$. These results suggest that the scale effectively differentiates students with high and low attitudes toward innovation, supporting its construct validity.

Table 11

Test-Retest Reliability of the Attitude Scale Toward Innovation for Elementary School Students

Factor	N	r	p
Curiosity (Factor 1)	93	.537	.000
Self-Confidence (Factor 2)	93	.530	.000
Alternative Usage (Factor 3)	93	.679	.000
Creativity (Factor 4)	93	.529	.000
Scale Overall	93	.753	.000

Table 11 presents the test-retest reliability results for the Attitude Scale Toward Innovation for Elementary School Students, based on a sample of 93 participants. The test-retest method involves applying the same test to the same individuals at different times under similar conditions. The reliability coefficient of this method shows the consistency and invariance of the property evaluated by the measurement tool over time (Doğan & Aybek, 2021). The correlation coefficients (r)between the two administrations of the scale indicate moderate to high stability over time, with all correlations being statistically significant *(p < .001)*. The test-retest reliability values for the subdimensions range between 0.529 and 0.679, demonstrating a consistent pattern across factors. The overall scale shows a higher

stability with a correlation coefficient of 0.753, indicating strong reliability in measuring students' attitudes toward innovation over time. These findings support the temporal consistency of the scale, suggesting that it provides reliable and consistent measurements across different time points.

4. Conclusion and Discussion

As a result of this study, which aimed to develop a measurement tool to assess elementary school students' attitudes toward innovation, the Attitude Scale Toward Innovation for Elementary School Students was developed, consisting of 4 factors and 12 items. The results of the exploratory factor analysis (EFA) indicate that the four factors comprising the scale explain 55.66% of the total variance. These factors were named Curiosity, Self-Confidence, Alternative Usage, and Creativity. Additionally, first-order and second-order confirmatory factor analysis (CFA) tests were conducted to validate the developed model. The results of the CFA tests indicate that the model demonstrates an excellent fit.

In the present study, the Attitude Scale Toward Innovation was developed to measure elementary school students' dispositions across four dimensions: Curiosity, Self-Confidence, Creativity, and Alternative Usage. Although these dimensions have been individually addressed in various instruments across the literature, no existing scale was found to incorporate all four constructs in a unified framework specifically designed for children. A review of previously developed innovation scales for adults reveals that the factors of Creativity (Ovacı & Yıldırım Saatçi, 2020), Self-Confidence (Altınışık et al., 2023), and Alternative Usage (Altınışık et al., 2023; Girardi et al., 2005) are similarly present in various scale applications, further confirming the theoretical relevance of these constructs. Yıldız (2021), in her social innovation scale, emphasized individuals' ability to find alternative solutions to social problems, revealing a conceptual overlap with the "Alternative Usage" dimension of this study. Furthermore, scales developed by Flight et al. (2011) and Alegre and Chiva (2006) include constructs such as "creativity" and "novelty seeking," supporting the theoretical basis for the curiosity and creativity dimensions identified here. In Clauss's (2016) Business Model Innovation Scale, dimensions such as "resource recombination" and "radical creativity" also parallel the notion of repurposing and imaginative transformation reflected in the Alternative Usage dimension of the current scale. Collectively, these studies support the multidimensionality and conceptual validity of the proposed scale by demonstrating that its components reflect broader theoretical constructs previously validated in innovation research, now adapted to the developmental context of elementary education.

Creativity and innovation are critically important at both individual and institutional levels for generating new ideas and their transformation into tangible products, processes, or services (Maravilhas, 2015; Patil, 2024). As the driving force of the innovation process, creativity facilitates developing new ideas and redesigning existing products or processes (Cropley, 2006; Okpara, 2007). Designing a product is achievable only through the combined application of creativity and innovation (Medyna et al., 2013). However, while creativity is a necessary condition for innovation, it is not sufficient on its own; suitable contexts in which creativity can thrive must also be established (Nayak & Agarwal, 2011). In this regard, it can be stated that creativity is a crucial component of innovation and that the emergence of innovation requires the creation of environments conducive to creativity.

Alternative usage is applying existing products in new domains or for different functions. Literature review reveals that alternative usage is considered one of the fundamental elements of innovation and is frequently mentioned in definitions of the concept. Damiano (2011) defines innovation as assigning new areas of use to a product. Similarly, Boak (2022) emphasizes that for an idea to be innovative, it must be new and valuable—in other words, innovation involves making existing elements more functional or practical. Boak (2022) describes innovation as not merely creating something new but ensuring it is good, essentially transforming what already exists into something more useful. Schumpeter (1911) emphasized that innovation is not necessarily about creating a new product but about discovering new areas of use for existing ones. These perspectives in the literature suggest that

innovation is not limited to producing new products but also involves modifying and transforming existing ones.

Curiosity is regarded as a fundamental element of innovation at both individual and societal levels, serving as the driving force behind scientific activities (Nowotny, 2008; Walsh et al., 2022). The relevant literature indicates that curiosity predicts innovation (Celik et al., 2016) and stimulates creativity (Gross et al., 2020). In this context, curiosity and creativity emerge as indispensable components of pursuing innovation (Ivancovsky et al., 2023), guiding individuals toward exploratory processes (Kuo, 2019). Thus, the motivational impact of curiosity plays a critical role in the emergence of innovation and innovative approaches.

Individual traits such as self-confidence, self-efficacy, and creativity are key determinants of innovation. High levels of self-confidence enhance individuals' willingness to take risks, facilitating their engagement in innovative endeavors (Karahan & Patir, 2021; Koellinger, 2007). Self-efficacy positively influences innovation by supporting individuals' motivation (Benabou & Tirole, 2002; Kumar & Uzkurt, 2010). Creative self-efficacy, in combination with self-beliefs such as identity, mindset, and metacognition, is a significant factor that strengthens individuals' innovative potential (Puente-Díaz & Karwowski, 2017). However, the impact of self-confidence may not always be positive; while over-optimism can be positively associated with innovation, overly critical self-confidence may lead to adverse outcomes (Herz et al., 2014). Innovation also requires persisting in seeking solutions despite setbacks, which indicates individuals' innovation skills (Gerber et al., 2012). Therefore, self-confidence can be regarded as a crucial element for innovative endeavors, aligning with the findings of this study.

In measurement tools developed for elementary school students in Turkey, 3-point (Uysal & Sarıça, 2018), 4-point (Akar & Uluçınar, 2023), and 5-point Likert-type response formats (Balantekin & Oksal, 2014; Hacıömeroğlu et al., 2013; Tahiroğlu & Çakır, 2014) have been utilized. However, considering the cognitive developmental characteristics of children, it has been noted that Likert scales based on verbal frequency expressions (e.g., “never” to “always”) are more comprehensible for students aged 6–10 compared to numeric ratings and yield greater consistency than yes/no formats (Mellor & Moore, 2014). The study by Adelson and McCoach (2010) also demonstrated that, within this age group, the 5-point Likert format provides higher reliability, stronger factor structures, and fewer model misfits compared to the 4-point version. Furthermore, students did not show an excessive tendency to select the neutral option. In addition, the use of visually supported Likert scales with facial expressions enhances children's engagement with all response categories, increases response variance, and improves data quality (Hall et al., 2016). In line with the literature, the present study concluded that the 5-point emoji-supported Likert scale offers a valid and reliable structure suitable for use with elementary school students.

Future research is recommended to apply the scale across a broader range of grade levels to assess its developmental appropriateness and structural stability. For younger students, such as those in 1st and 2nd grades, simplified item wording and visually supported response formats (e.g., pictorial Likert scales) may be necessary to accommodate their cognitive and linguistic capabilities. Applications with upper primary grades, such as 5th and 6th, could further test the consistency of factor structures and reveal how attitudes toward innovation evolve with age. These efforts would contribute to validating the scale as a developmentally robust instrument for longitudinal and cross-sectional research in primary education.

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reveal how attitudes toward innovation evolve with age. These efforts would contribute to validating the scale as a developmentally robust instrument for longitudinal and cross-sectional research in primary education. Furthermore, the scale can be utilized in future studies to examine how various demographic variables—such as gender, socioeconomic status, parental education level, and school type—affect students' attitudes toward innovation in elementary education. Such comparative analyses would help identify which student profiles are more inclined toward innovative thinking and could inform the development of targeted pedagogical strategies. In addition, both descriptive and correlational research could explore individual (e.g., self-efficacy, curiosity) and contextual (e.g., teacher support, classroom climate) variables that potentially enhance innovation in early education. Identifying these contributing factors at an early stage may facilitate the development of instructional practices that effectively nurture innovation-related dispositions among young learners.

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Attitude Scale Toward Innovation for Primary School Students

No	Item	Strongly Disagree 	Disagree 	Neutral 	Agree 	Strongly Agree 
1	Çevremde olanları gözlemlerim. (I observe what is happening around me.)					
2	Merak ettiğim konularda sorular sorarım. (I ask questions about topics I am curious about.)					
3	Yeni bir şey görünce onu dikkatle incelerim. (When I see something new, I scrutinize it.)					
4	Yeni bir şey üretirken güçlüklerle karşılaşınca pes etmem. (I do not give up when encountering difficulties while creating something new.)					
5	Hayallerimi gerçekleştirene kadar pes etmem. (I do not give up until I achieve my dreams.)					
6	Yeni bir şeyler yapma konusunda kendime güvenirim. (I am confident in my ability to create new things.)					
7	Kırılan oyuncaklarımı yeni oyuncaklara dönüştürürüm. (I transform broken toys into new ones.)					
8	Atık malzemelerden yeni şeyler üretmeyi severim. (I enjoy creating new things from waste materials.)					
9	Farklı şeylerden kendime yeni oyuncaklar üretmeyi severim. (I like making new toys for myself from different materials.)					
10	Hayal gücümü kullanmayı gerektiren etkinlikleri severim. (I like activities that require using my imagination.)					
11	Yeni bir şeyler icat etmek isterim. (I want to invent new things.)					
12	Yeni şeyler icat edebildiğim dersleri severim. (I enjoy lessons where I can invent new things.)					

Items 1, 2 and 3 Curiosity, Items 4, 5 and 6 Self-Confidence Items 7, 8 and 9 Alternative Usage, Items 10, 11 and 12 are included in Creativity factors. There is no reverse item. (İlkokul Öğrencileri için İnovasyona Yönelik Tutum Ölçeği - Madde 1, 2 ve 3 Merak, Madde 4, 5 ve 6 Özgüven Madde 7, 8 ve 9 Farklı Kullanım, Madde 10, 11 ve 12 Yaratıcılık faktörleri içerisinde yer almaktadır. Ters madde bulunmamaktadır.)

We support open science policy. For this reason, you can use the scale in educational research in which the scale is implemented to students with ethics committee permission with citation. For other purposes, please contact the authors. (Açık bilim politikasını destekliyoruz. Bu nedenle ölçeğin öğrencilere uygulandığı eğitim araştırmalarında etik kurul izni dahilinde atıf vererek kullanabilirsiniz. Farklı amaçlardaki araştırmalar için lütfen yazarlar ile iletişime geçiniz.)

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Research Article

The Role of Value on Mathematics Between Self-Efficacy and Like Mathematics: A Moderated Mediation Analysis

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Abstract: This study examines the moderating effects of parents' belief in the importance of mathematics on the relationship between students' mathematics self-efficacy and their enjoyment of mathematics among 8th-grade students in the TIMSS 2019 data. Mediation analysis revealed that higher self-efficacy in mathematics increased students' enjoyment of the subject, with students' value of mathematics partially mediating this relationship. The parents' attitudes significantly moderated the mediating effect, emphasizing their critical role in shaping students' attitudes toward mathematics. Notably, the indirect effect of students' value of mathematics was more substantial when parents did not perceive mathematics as important. These findings highlight the complex interplay among students' self-beliefs, their value of mathematics, and parents' value of mathematics, collectively influencing students' enjoyment of mathematics. Further research could explore the implications of these relationships for educational practices.

Keywords: Mathematics Self-Efficacy, Parents' Value of Mathematics, Students Like Learning Mathematics, Students' Value of Mathematics

1. Introduction

Mathematics plays a crucial role in personal growth and development across various scientific fields and everyday life (Sharma, 2021). Considering this, it is not unexpected for mathematical achievement to be highly valued. Various research studies are conducted to increase mathematical achievement. Researchers believe that it is crucial to identify significant factors that influence exam performance, particularly those that can be changed through intervention and may result in enhanced academic achievement (Stankov et al., 2012). For example, mathematics educators have observed the connection between cognition and emotion and the impact of emotions on promoting creativity in mathematics (Di Martino & Zan, 2011). The relationship between cognition and emotion in mathematics education research is referred to as affect. Studies in this area have increased in recent years (Chen, 2022; Di Martino, 2019; Dowker et al., 2019; Hwang et al., 2017). Since it serves as a link between beliefs and emotions, attitudes toward mathematics is particularly interesting within the affected domain (Di Martino & Zan, 2011).

Di Martino and Zan (2010) developed a multidimensional model to define attitude based on practicality. This model consists of three components: emotional disposition (liking or disliking mathematics), vision of mathematics (instrumental or relational), and perceived competence (success or failure in mathematics). The study revealed that the interactions between the three components of attitude impact mathematical understanding and shape pupils' mathematics encounters in various ways. This approach emphasized the crucial role of attitude in connecting beliefs and emotions, enabling the exploration of how students' feelings towards mathematics, their self-beliefs, and their beliefs about the subject interact with each other (Di Martino & Zan, 2011). Hwang et al. (2017) stated that it would offer a suitable foundation for understanding the connection between attitudes toward mathematics and performance in mathematics.

Researchers claim that the interactions between cognition and emotion are most likely to occur when dealing with unfamiliar or difficult tasks. Based on this, some researchers have suggested that the Trends in International Mathematics and Science Study (TIMSS) shows how students can solve non-

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routine and multi-step problems as they can solve a routine problem in unfamiliar ways (Mullis et al., 2012; Hwang et al., 2017). The TIMSS provides an extensive dataset for investigating the connection between students' attitudes and reasoning abilities (Ferrini-Mundy & Schmidt, 2005). Therefore, in this study, we used the TIMSS 2019 international database, which is the latest available dataset. Particularly, we focused on four components of attitude toward mathematics. These are Students' Mathematics Self-Efficacy (MSE), Students Like Learning Mathematics (SLM), Students Value Mathematics (SVM), and Parents' Valuing of Mathematics (PVoM). We believe that there is a relationship between the theoretical framework proposed by Di Martino and Zan (2010) and the analytical methodology employed to assess attitude in TIMSS 2019.

1.1. Mathematics Self-Efficacy (MSE)

Students' self-efficacy beliefs relate to their assessments of confidence in their ability to complete academic tasks or achieve success in certain academic activities (Pajares & Graham, 1999). Students' self-efficacy has been examined as a personal attribute that directly impacts their actions in settings linked to mathematics (Bandura, 1997). According to Schunk and DiBenedetto (2021), students who have confidence in their mathematical skills are more likely to persist and put in effort to learn, which ultimately impacts their academic achievement. Research has shown that students with a high level of mathematics self-efficacy tend to perform better, set more ambitious objectives, and have greater resilience in the face of difficulties (Bandura, 1997). Researchers in mathematics have prioritized the importance of individuals' self-efficacy in mathematics as it is a strong indicator of their academic achievement (Lee, 2009; Pajares & Graham, 1999; Stajkovic et al., 2018).

Several studies have shown that students' mathematical performance at various educational levels in different educational systems is influenced by their mathematics self-efficacy. For example, Stankov et al. (2014) found a positive correlation between secondary students' mathematics self-efficacy and mathematics achievement. In another research with secondary students, Ayotola and Adedeji (2009) revealed a strong positive relationship between students' self-efficacy and mathematics achievement. The pupils who have a higher level of self-efficacy in mathematics are generally associated with higher levels of mathematical performance (Caprara et al., 2008). Although there is a well-established positive correlation between mathematics self-efficacy and mathematics achievement, this link may not hold true when examining different groups, such as districts or countries. For instance, a comparison analysis using the 2003 dataset from the Programme for International Student Assessment (PISA) conducted by Lee (2009) revealed that several high-achieving Asian nations (Japan, South Korea) obtained the lowest scores in terms of their belief in their ability to succeed in mathematics when compared to 41 other countries. Various cultures influence the development of human nature, resulting in a variety of forms (Bandura, 2002). The self-efficacy judgment of students is significantly influenced by their cultural environment (Chen & Zimmerman, 2007). On the other hand, Usher (2009) has explicitly investigated the factors that contribute to middle school students' belief in their ability to succeed in mathematics.

1.2. Students Like Learning Mathematics (SLM)

Liking learning mathematics, a critical affective factor linked to mathematical achievement, involves the emotional and behavioral responses of students towards their interest in mathematics (Mullis et al., 2012). Studies conducted internationally (Mohammadpour, 2012) have found that students who like learning mathematics tend to achieve better levels of mathematics achievement. In a study conducted using TIMSS 2011 data (Yoo, 2018), the effect of liking learning mathematics on Singapore pupils' mathematics achievement was analyzed. It was found that the attitude of eighth-grade boys towards "liking learning mathematics" does not have a significant effect on their mathematical achievement. Moreover, it has a slightly negative significant effect on girls' achievement in mathematics. This finding suggests that despite their high levels of achievement, eighth-grade pupils in Singapore may not like learning mathematics. In another study (Yavuz et al., 2017), TIMSS 2007 and TIMSS 2011 datasets were

used. According to the study's findings, students who participated in the TIMSS 2007 and liked learning mathematics had a higher level of mathematics achievement. On the contrary, "like learning mathematics" was observed to negatively affect the mathematics achievement of students participating in the TIMSS 2011. However, considering the size of the effect of this result, it was understood that the negative impact was negligible.

1.3. Students' Value Mathematics (SVM) as mediator and Parents' Valuing of Mathematics (PVoM) as moderator

Students' valuing of mathematics is connected to their external motivating factors and reflects their view on the significance and advantages of mathematics (Wigfield & Eccles, 2000). A study conducted on TIMSS 2011 data analyzed the impact of valuing mathematics on the academic achievements of fourth and eighth-grade students in South Korea, Singapore, and Finland using hierarchical linear modeling analysis. The findings revealed that students' valuing of mathematics had positive effects on mathematics achievement for students in South Korea and Singapore (Kim et al., 2013). Similarly, a study conducted by Phan et al. (2010) utilized TIMSS 2003 data and employed Hierarchical Linear Modeling (HLM) to examine the relationship between eighth-grade students' valuing of mathematics and their mathematics achievements in developed countries (Canada and the USA) and developing countries (Egypt and South Africa). The study revealed a positive correlation between students' valuation of mathematics and their achievement in mathematics. However, the study conducted by Arıkan et al. (2016) found no significant correlation between mathematics achievements and the eighth-grade students' valuing of mathematics who participated in the exams in Türkiye and Australia in 2007 and 2011. A notable aspect of the studies that were conducted is the emergence of varying outcomes across different countries. Additionally, in another study (Yavuz et al., 2017), according to both TIMSS 2007 and TIMSS 2011 data, no significant relationship was found between students' valuing of mathematics and mathematics achievement.

Parents and other family members serve as children's initial educators, impacting their acquisition of mathematical knowledge and skills (Phillipson et al., 2017). Consequently, parents' attitudes toward math education can be seen as valuable assets shaping children's early mathematical development (Hawighorst, 2005). Students who felt their parents valued mathematics showed higher motivation levels compared to others (Lazarides et al., 2016). On the other hand, another study showed that early numeracy activities could be attributed to parental mathematics values, but they did not relate to children's mathematics achievement (Missall et al., 2015). An individual's increasing self-efficacy in math might persuade their family members to value math more, which fosters positive emotions about mathematics throughout the family.

1.4. Present study

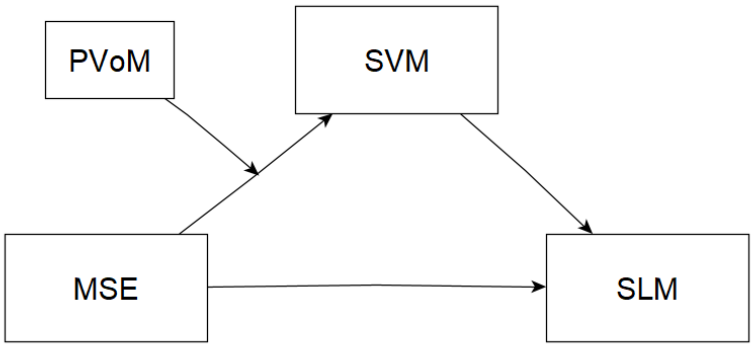
The purpose of this study is to examine the impact of Mathematics Self-Efficacy on Students Like Learning Mathematics, utilizing data from TIMSS 2019, with a focus on Students Value Mathematics as the mediator and Parents' Valuing of Mathematics as the moderator. Based on Bandura's (1997) general theory, expectations of self-efficacy influence critical outcomes such as people's activity selection, effort spent, and persistence when confronted with challenges. Students who had stronger self-efficacy in mathematics were more likely to like the course (Laranang & Bondoc, 2020). Pinxten et al. (2014) expanded on this by finding a reciprocal relationship between enjoyment and competence views in mathematics, with both characteristics influencing achievement and perceived effort expenditure. These findings show that people who are more confident in their mathematics ability will like the topic more. Therefore, the first hypothesis is that there is a relationship between mathematics self-efficacy and students like learning mathematics (H_1).

Jacquelynne Eccles and her colleagues designed the expectancy-value theory. According to the theory, achievement-related choices are driven by a combination of individual achievement expectations and personal assessment of tasks in specific domains. Children, for example, are more inclined to participate in an activity if they believe they will succeed and value the activity (Wigfield & Eccles, 2000). In this line, researchers suggest that it is necessary to effectively demonstrate the logical and valuable aspects of mathematics (Wilkerson, 2020). Güner (2012) further proposes that recognizing the utility of mathematics can contribute to the development of a positive attitude towards the subject. Perceiving mathematics as valuable and relevant to daily life often fosters a positive engagement with the subject among individuals. Therefore, the second hypothesis is that students' valuing of mathematics plays a mediating role between mathematics self-efficacy and students like learning mathematics (H_2).

Enhanced confidence in mathematical proficiency motivates individuals to participate in math-related activities actively, actively seek avenues for expanding their mathematical knowledge, and openly express their enthusiasm for mathematics to their parents. Moreover, when parents place importance on mathematics and offer encouragement and assistance for mathematical education, their children tend to develop positive attitudes towards mathematics. Therefore, the third hypothesis states that parents' valuing of mathematics (PVoM) has a moderate mediating effect on students' value of mathematics (SVM) on the link of mathematics self-efficacy (MSE) with students like learning mathematics (SLM) (H_3). Figure 1 shows the moderated mediation model hypothesized as H_1, H_2 and H_3.

Figure 1

Moderated Mediation Model Examined in the Study



In the literature, although there are numerous studies showing that mathematics self-efficacy affects mathematics achievement (Ayotola & Adedeji, 2009; Stajkovic et al., 2018), the value placed on mathematics affects mathematics achievement (Kim et al., 2013; Phan et al., 2010;) and that liking learning mathematics influences mathematics achievement (Mohammadpour, 2012), there are also studies indicating that these variables (MSE, SLM and SVM) have no effect or have a negative effect (Arıkan et al., 2016; Lee, 2009; Yavuz et al., 2017; Yoo, 2018). This situation may stem from cultural differences. According to data on the attitudes of Turkish parents and teachers, children in Turkish society are socialized within a collectivist culture where individual needs, interests, autonomy, and self-sufficiency are frequently disregarded. This results in a prioritization of academic success in a child's socialization and education (Aslan & Cansever, 2009). Also, there is no other research in the literature that examines all of the variables of mathematics self-efficacy, like learning mathematics, students value mathematics and parents' valuing of mathematics together. In this study, the aim is to examine Türkiye, a country lagging behind in TIMSS.

Moreover, there is a significant gap in the existing literature: no previous research has examined mathematics self-efficacy, students' liking of mathematics, students' valuing of mathematics, and

parents' valuing of mathematics together within a single model. This study aims to address this gap by examining these interrelated variables simultaneously in Türkiye, a country that has consistently lagged behind in the TIMSS assessments. By understanding how students' and parents' attitudes toward mathematics interact to influence students' enjoyment of mathematics, the study seeks to provide insights for educators, policymakers, and curriculum developers aiming to enhance students' positive attitudes toward mathematics in collectivist cultural contexts. Therefore, this research is important not only for contributing to the international literature on mathematics education but also for guiding educational reforms and family involvement initiatives in Türkiye and similar societies.

2. Methodology

2.1. Sample

In this study, the student dataset from TIMSS 2019 was used. TIMSS is an international survey and assessment method that primarily focuses on fourth and eighth-grade students' mathematics and science achievement. Besides reporting student achievement, TIMSS collects several variables about teachers, curriculum, home and school contexts, as well as psychological variables about the courses. A total of 72 countries participated in TIMSS 2019 from different regions and cultures. We focused on 4,077 eighth-grade students from Türkiye sample. According to Little's MCAR test, the mechanism of missing data was not MCAR (χ^2= 2069.89, df = 1666, p< 0.001). Thus, 477 (%11) students with missing data were considered as missing at random (MAR). The listwise deletion method was used to handle missing data; further analyses were carried out with 3600 students. 50.5% of the sample was female. The mean age of the students was 13.9 years (±0.41). Through the international benchmark estimations of students' mathematics achievement, 19.7% were below 400, 24.3% were at or above 400 but below 475, 24.6% were at or above 475 but below 550, 19.9% were at or above 550 but below 625, and 11.6% were at or above 625 in terms of PV1MAT. Their parents' highest education level frequencies are as follows: 12.8% university or higher, 7% post-secondary but not university, 27.3% upper secondary, 28.9% lower secondary, 16.9% some primary, lower secondary or no school, and 3.9% information.

2.2. Measures

We used TIMSS's measures named Students Like Learning Mathematics (SLM), Mathematics Self-Efficacy (MSE), Students' Value Mathematics (SVM), and Parents' Value Mathematics (coded as BSBM20H) as moderator variable.

2.2.1. Students like learning mathematics

SLM was constructed by combining items coded as follows:

Table 1

SLM Items

Code	Items
BSBM16A	Enjoy learning mathematics
BSBM16B	Wish have not to study math†
BSBM16C	Math is boring†
BSBM16D	Learn interesting things
BSBM16E	Like mathematics
BSBM16F	Like numbers
BSBM16G	Like math problems
BSBM16H	Look forward to math class
BSBM16I	Favorite subject

Note: †Reverse items, Items were 4-point Likert type as 1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot.

First, we checked the assumptions. Multivariate outliers were checked by Mahalanobis Distance (p<0.001) and 105 outliers were removed from the datasets. Exploratory factor analysis (EFA) was performed with the remaining 3,495 individuals. Through the multicollinearity assumption, VIF values ranged between 1.52 to 4.64, tolerance values ranged between 0.22 to 0.66, and CI values ranged between 1.00 to 16.22. This means that there is no multicollinearity (Tabachnick et al., 2020). We examined the multivariate normality via Mardia's Multivariate Skewness coefficient, and it was statistically significant (skewness = 4878.26, p<0.01). The multivariate normality assumption was violated through the analysis. We chose the unweighted least squares (ULS) factor extraction method for EFA because of its robustness against violation of the multivariate normality assumption.

We used parallel analysis (PA), minimum average partial (MAP), and Hull methods for factor retention. PA, MAP, and Hull suggested a unidimensional structure. We examined the factor structure of the SLM using a polychoric correlation matrix and the ULS factor extraction method. Results suggest that a unidimensional structure was sufficient. The total explained variance was 70.85% and factor loadings ranged between 0.68 to 0.95. According to explained variance and factor loadings, the unidimensional structure was appropriate for SLM. We used the total score of SLM for mediation analysis. Reliability analysis points out that McDonald's Omega was 0.95 and Cronbach's Alpha was 0.93 for SLM, indicating high internal consistency.

2.2.2. Mathematics self-efficacy

MSE was constructed by combining items coded as follows:

Table 2

MSE Items

Code	Items
BSBM19A	Usually do well in math.
BSBM19B	Mathematics is more difficult†
BSBM19C	Mathematics is not my strength†
BSBM19D	Learn quickly in mathematics.
BSBM19E	Math makes nervous†
BSBM19F	Good at working out problems
BSBM19G	I am good at mathematics.
BSBM19H	Mathematics harder for me†
BSBM19I	Math makes confused†

Note: †Reverse items, Items were 4-point Likert type as 1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot.

Through the assumptions, 75 multivariate outliers were detected and removed. EFA was performed with the remaining 3,525 individuals. VIF values ranged between 1.69 to 2.79, tolerance values ranged between 0.36-0.59, and CI values ranged between 1.00 to 15.09. This means that there is no multicollinearity (Tabachnick et al., 2020). We examined the multivariate normality via Mardia's Multivariate Skewness coefficient, and it was statistically significant (skewness = 1471.33, p<0.01). We chose ULS factor extraction method for EFA because of its robustness against violation of the multivariate normality assumption.

We used PA, MAP, and Hull methods for factor retention. PA suggested a unidimensional structure, whereas MAP and Hull suggested two factors. The unidimensional structure explained a total variance of 61.09%. Factor loadings for the unidimensional structure ranged between 0.63 and 0.84. According to the variance and factor loadings explained, the unidimensional model was appropriate for MSE. Therefore, we used the MSE total score for mediation analysis. McDonald's Omega was 0.93, and Cronbach's alpha was 0.90 for MSE, indicating high internal consistency.

2.2.3. Students value mathematics

Students Value Mathematics (SVM) was constructed by combining items coded as follows:

Table 3

SVM Items

Code	Items
BSBM20A	Mathematics will help me.
BSBM20B	Need maths to learn other things.
BSBM20C	Need math to get into <uni>
BSBM20F	Get ahead in the world.
BSBM20I	Important to do well in math

Note: Items were 4-point Likert type as 1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot.

Through the assumptions, 119 multivariate outliers were detected and removed. EFA was performed with the remaining 3,481 individuals. VIF values ranged between 1.51 to 2.16, tolerance values ranged between 0.46 to 0.66, and CI values ranged between 1.00 to 8.55. This means that there is no multicollinearity (Tabachnick et al., 2020). We examined the multivariate normality via Mardia's Multivariate Skewness coefficient, and it was statistically significant (skewness = 6769.86, p<0.01). We chose ULS factor extraction method for EFA because of its robustness against violation of the multivariate normality assumption.

PA, MAP, and Hull suggested a unidimensional structure. Thus, we examined the unidimensional factor structure of SVM using a polychoric correlation matrix and ULS factor extraction method. The total explained variance was 65.99%, and factor loadings ranged between 0.68 and 0.89. So, SVM was unidimensional. We used the SVM total score for mediation analysis. McDonald's Omega was 0.88, and Cronbach's Alpha was 0.81 for SVM, indicating high reliability.

2.3. Moderator variable

The moderator variable was coded BSBM20H (Parents think math is important) named as PVoM in the current study. It was also a 4-point Likert scale like the other variables (1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot). The distribution of the moderator variable was analyzed by frequencies for each category. Frequencies by categories were 72.30% (n= 2,601) for 1, 19.40% (n=699) for 2, 4.80% (n=173) for 3, and 3.5% (n=127) for 4. To examine the moderator effect for every category, we combined the 2, 3, and 4 categories. Kılıç and Uysal (2021) stated that combining categories of variables may be acceptable in terms of analyses. Thus, we combined the categories like 1 (Agree a lot), which was the most chosen category, and 2 (the others), which includes 2nd, 3rd, and 4th categories.

2.4. Data analysis

James and Brett (1984) proposed the idea of moderated mediation, which determines if W affects the size of an indirect effect (Clement & Bradley-Garcia, 2022; Preacher et al., 2007). Moderated mediation examines whether the mediational pathways differ across moderator levels. Therefore, we used moderated mediation analysis to examine the relationship between MSE, SLM, SVM, and the moderator variable, which was about Parents' thinking that math is important (BSBM20H) named as PVoM.

First, we investigated the dataset in terms of moderated mediation assumptions. These assumptions include the following: the observations are independent, there is a linear relationship between the variables, the error values have equal variances (homoscedasticity), there is no multicollinearity among the independent variables, and the error values are normally distributed (Clement & Bradley-Garcia, 2022; Hayes, 2022). We used the Durbin-Watson statistic to examine the independence of residual terms. The Durbin-Watson statistic in our dataset is 1.89, indicating that the assumption of independence of residuals is satisfied (Field, 2024). We examined the scatter plot created via

unstandardized predicted values and standardized residuals. Because the data is horizontal, the homoscedasticity assumption was held. For multicollinearity, we examined the VIF, CI, and TV values. VIF, TV, and CI values ranged between 1.18-1.50, 0.59-0.85, and 1.00-6.45, respectively. These results indicate that the multicollinearity assumption was held (Tabachnick et al., 2020). We used the observed cumulative probability and expected cumulative probability graph to examine the normality of error terms. Because the graph is linear like the y=x line, this assumption was held.

Process Macro is mainly used for mediation, moderation, or related analysis. We assessed the importance of indirect effects by employing the bootstrapping approach with 5,000 resamples to obtain 95% confidence intervals (Hayes, 2022). We conducted EFA analysis with Factor software (Lorenzo-Seva & Ferrando, 2023) and moderated mediation analysis with SPSS version 26 with Process Macro (v4.2) (Hayes, 2022) using Model 7.

3. Results

3.1. Descriptive statistics

We examined the mean (sd), skewness, kurtosis, and bivariate correlations among variables. The means of the variables were 18.84 (±7.47), 21.78 (±7.00), and 8.39 (±3.41) for SLM, MSE, and SVM, respectively. Skewness of the SLM, MSE, and SVM were (0.53), (-0.06), and (1.27). Kurtosis of the SLM, MSE, and SVM were (-0.66), (-0.72), and (1.405). The moderator variable's (Parents think math is important) categories' percentages were 1 for 72.30% (n = 2,601) and 2 for 27.70% (n = 999). Bivariate correlations in terms of PVoM (Parents Value on Mathematics) categories are presented in Table 4.

Table 4

Bivariate Correlations

Variable	SLM	MSE	SVM
SLM	-	0.65**	0.55**
MSE	0.71**	-	0.30**
SVM	0.56**	0.37**	-

Note: **p<0.01, MSE: Mathematics Self-Efficacy, SVM: Students Value Mathematics, SLM: Students Like Learning

The correlation matrix in Table 4 shows the correlation analysis results obtained from different groups in the lower triangle and upper triangle. The lower triangle of the correlation matrix in Table 4 shows the correlations obtained only from the group that marked "Agree a lot" on the item Parents Value on Mathematics (PVoM), while the upper triangle of the matrix shows the correlations obtained from the group excluding those who marked "Agree a lot". Accordingly, when the correlations obtained from the "agree a lot" group are analyzed, the correlation between MSE and SVM is 0.37, the correlation between SVM and SLM is 0.56 and the correlation between MSE and SLM is 0.71. These correlations were 0.30, 0.55 and 0.65, respectively, in the group marking other than agree a lot to PVoM. It can be said that the correlations are higher in the group that marked Agree a lot. Finally, the correlation coefficients obtained from the whole group without grouping by PVoM are 0.38, 0.58 and 0.70, respectively. It was observed that all correlations were significant at the 0.01 level. Correlations between each variable for subgroups and all groups were statistically significant and relatively moderate-high. Accordingly, hypothesis H_1 was accepted.

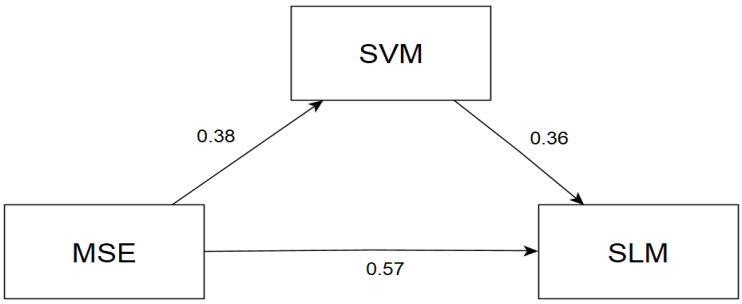
3.2. Mediation and moderated mediation analysis

First, mediation analysis showed that MSE had a significant predictive effect on SVM (β= 0.18, p<0.01). Similarly, MSE (β = 0.61, p<0.01) and SVM (β = 0.79, p<0.01) had a significant predictive effect on SLM. The total effect was 0.75 (t= 59.44, p<0.01, LLCI: 0.73 - ULCI: 0.78) and the indirect effect of SVM on SLM was 0.15 (LLCI: 0.13-ULCI:0.16). Therefore, SVM partially mediated the effect of MSE on SLM. Accordingly, H_2 (students value mathematics plays a mediating role between mathematics self-efficacy

and students like learning mathematics) was accepted. Standardized estimates are presented in Figure 2.

Figure 2

Standardized Estimates of the Mediation Model



The indirect effect accounted for 19.41% of the total effect. After conducting an analysis of the mediating impact, we further investigated the moderated mediation effect to see if parents' perception of the importance of math influenced the mediating effect of SVM in the relationship between MSE and SLM. The analysis revealed that MSE and PVoM highly influenced SVM, explaining 26% of the variability in SVM (see Table 5). The impact of parents' thoughts considerably influenced the relationship between MSE and their value for mathematics (interaction effect $\beta = 0.05$, $p<0.05$; $\Delta R^2 = 0.001$). The results of the analysis showed that there was a significant difference in the indirect effect of MSE on SLM between the category of moderator variable that was high (categorized as 1 for agree a lot) and the other categories (categorized as 2 for the rest) as seen in Figure 3.

Figure 3

The Moderation Effects of Both Groups of Moderator Variables (PVoM)

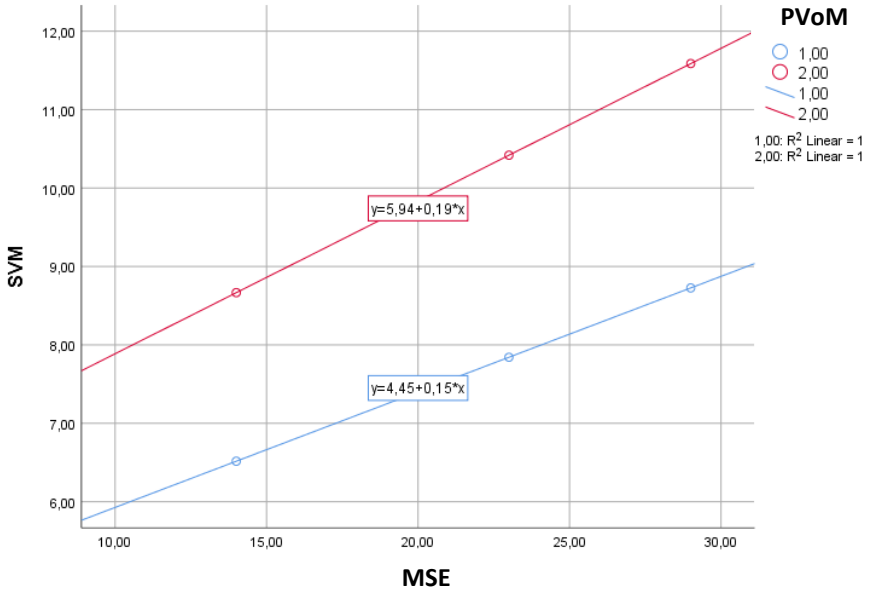


Table 5

Unstandardized Coefficients for the Moderated Mediation Model

	M (SVM [Students Value Mathematics])			Y (SLM [Students Like Learning Mathematics])		
	Coeff.	SE	t	Coeff.	SE	t
X (MSE)	0.10	0.02	4.44**	0.61	0.01	50.24**
M (SVM)	-	-	-	0.79	0.03	31.97**
W (Parents)	1.49	0.43	3.47**	-	-	-
X.W	0.05	0.02	2.65**	-	-	-
Constant	2.97	0.53	5.65**	-0.97	0.27	-3.52**
	R^2 = 0.26, F =413.50, p<0.01			R^2 = 0.61, F =2778.30, p<0.01		
Conditional Indirect effects of MSE on SLM						
Parents think math important	Effect			BootSE	BootLLCI	BootULCI
1 (Agree a lot)	0.12			0.01	0.10	0.13
2 (The others)	0.15			0.02	0.12	0.19
Index of moderated mediation (difference between conditional indirect effects)						
Parents think math important	Index			BootSE	BootLLCI	BootULCI
	0.04			0.02	0.00	0.07

Note: **p<0.01, Level of all confidence intervals are 95%, number of bootstrap samples for percentile bootstrap confidence intervals: 5000

Further results revealed that PVoM moderated the mediating effect. Therefore, the indirect effect for students whose parents think math is important "Agree a lot" group is lower than the others (group 2). These findings indicate that the indirect effects of MSE on SLM with the mediator role of SVM are moderated by parents thinking about mathematics, whether it is important or not. Accordingly, H_3 (parents' valuing of mathematics (PVoM) has a moderate mediating effect on students value of mathematics (SVM) on the link of Mathematics Self-Efficacy (MSE) with Students Like Learning Mathematics (SLM) was accepted. This finding reveals the effects of whether parents think math is important on students value of mathematics. Note that it is important that perceptions of parents were reported by students. Therefore, these findings are crucial as they indicate the reflections of parents' perceptions about mathematics on students.

4. Discussion

This study investigates the influence of self-efficacy, valuing mathematics, and parental attitudes on students' mathematical achievement using data from TIMSS 2019. According to our findings, the first hypothesis that there is a relationship between mathematics self-efficacy and liking learning mathematics was confirmed (H_1). These findings are consistent with the results of previous research (Laranang & Bondoc, 2020). As students feel competent in mathematics, their achievement may increase (Ayotola & Adedeji, 2009; Bandura, 1997), and they may enjoy learning mathematics more with this feeling of satisfaction. On the contrary, Ertürk and Erdinç Akan (2018) found that fourth and eighth-grade students' self-confidence in mathematics negatively predicted mathematics achievement. Similarly, in Çavdar's (2015) study based on TIMSS 2011 Türkiye data, the variable of self-confidence in mathematics had a negative effect on mathematics achievement. This difference may be attributed to the fact that the samples used in previous studies and our study differ, and we utilized TIMSS data from different years. Moreover, the mathematics curriculum in Türkiye has undergone two revisions since the aforementioned studies, and changes in curricular content and instructional methods may have influenced the observed outcomes.

The second hypothesis that students value mathematics plays a mediating role between mathematics self-efficacy and liking learning mathematics was confirmed (H_2). These findings are consistent with the results of previous research. For example, Andersen and Smith (2024) analyzed TIMSS 2015 data from three countries (Norway, Italy, and Canada) and found that students' valuing of mathematics subjects is very important for self-concept. In another study, Hwang et al. (2017) examined the data of US and Finnish students in TIMSS 2011. In this study, a significant positive relationship was found between SLM and SVM in both countries. There is also a study (Yavuz et al., 2017) examining the effect of these variables on mathematics achievement with TIMSS 2007 and 2011 Türkiye data. As a result, students enjoy learning mathematics more when they value mathematics. In addition, if they also value mathematics, they like mathematics more (Hwang et al. 2017). Therefore, if a student with low mathematics self-confidence values mathematics, the likelihood of liking mathematics will increase.

The third hypothesis that parents' valuing of mathematics (PVoM) has a moderate mediating effect on students' value of mathematics (SVM) on the link of Mathematics Self Efficacy (MSE) with Students Like Learning Mathematics (SLM) was confirmed (H_3). These findings are consistent with the results of previous research. Similarly, Yoo (2018) found positive relationships between parental involvement in education and SLM in a study analyzing the TIMSS 2011 data of 8th-grade students. In addition, in the same study, significant positive relationships were found between confidence in Mathematics and parental involvement in education and between confidence in Mathematics and SLM. When parents place a high value on mathematics, this affects how much their children value mathematics. This influence arises from the parents' role in shaping the home learning environment (Trickett et al., 2022). Additionally, parents are responsible for organizing their children's leisure time after school. By valuing mathematics, parents provide guidance that encourages their children to also value and develop an interest in mathematics.

On the other hand, the indirect effect of SVM was higher in the "not agree a lot" group than in the "agree a lot" group. This difference might stem from perceived parental pressure among students, potentially leading to anxiety rather than a genuine, loving mathematical learning (Macmull & Ashkenazi, 2019). It's worth noting that these perceptions were reported by the students themselves. Moreover, intrinsic motivators seem to have a greater impact on learning mathematics compared to extrinsic motivators. Research suggests that children are more likely to engage in activities when they believe in their ability to succeed and find value in the activity (Wigfield & Eccles, 2000). This underscores the importance of effectively demonstrating the logical and valuable aspects of mathematics (Wilkerson, 2020). These findings align with expectancy-value theory, a well-established framework in educational research for studying motivation (Rodríguez et al., 2021).

The findings of the study show that mathematics self-efficacy positively affects students ' learning of mathematics. Therefore, it seems important to improve students' mathematics self-efficacy. In this regard, it may be necessary to revise Türkiye's education and training policies and to take steps to improve students' mathematics self-efficacy. By supporting students with low to moderate mathematics self-efficacy in developing a sense of competence in mathematics, their liking for learning mathematics can be enhanced. On the other hand, measures should be taken to ensure that the self-efficacy of students with high mathematics self-efficacy doesn't decrease. According to the other findings of this study, it seems important for both parents and students to value mathematics to foster a liking for learning mathematics. Therefore, raising awareness about the importance of mathematics is crucial. To achieve this goal, the Ministry of National Education can develop policies. Additionally, family education programs can be designed to support children with their parents. When teaching mathematics, teachers can make intriguing introductions by emphasizing the importance of the subject.

This research has some limitations. First of all, since it is a cross-sectional study, it does not provide information on causality. Therefore, longitudinal or experimental studies can be designed in the future.

Secondly, the data are limited to the measurement tools created by TIMSS. A similar study can be applied with other scales on the same variables. The third limitation is that the study was conducted using only Turkish data. This study can be conducted with data from all countries in TIMSS 2019. In addition, according to the results of TIMSS 2019, the most successful countries can be compared with the data of Türkiye, which ranks in last place.

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Research Article

Investigation of Cyberloafing Behaviours of University Students: Sakarya University Case

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Abstract: Cyberloafing refers to students using the Internet for personal reasons during academic activities, affecting their academic performance. This study investigates the prevalence, causes, and effects of cyberloafing among Sakarya University students. The aim is to explore the frequency of cyberloafing behaviors and their impact on students' academic performance at Sakarya University. Data were collected from 344 students at Sakarya University through a convenience sampling method. The study included students from Vocational Schools, Faculties, and Institutes. Data were collected between June 8, 2023, and January 12, 2024. There were no missing data. 66.9% of the students spend 3 hours or more daily on social networks, with the majority using smartphones (73.2%) or tablets (13.9%). Science department students exhibited less cyberloafing compared to social sciences students, likely due to hands-on experiments and application-based learning in their courses. Universities should update course content to engage students and enforce stricter technology use policies. Mentoring and behavioral change programs could help improve students' digital habits. Expanding this research to other universities is recommended for broader insights.

Keywords: Cyberloafing, Smart Devices, IT, Higher Education, University Students

1. Introduction

According to the annual market bulletin report for 2023 prepared by ICTA, the number of 4.5G subscribers and the total number of mobile subscribers have increased over the years. Although the increase between 2019 and 2023 is considered normal, the continuous movement of devices using mobile connection brings with it a line gap. In 2023, the number of mobile subscribers is 84.92%. According to the report published by Statista in December 2023, a significant portion of the web traffic in Türkiye is on smartphones and tablet devices. The main feature of these devices is that their ergonomic design allows easy transport and use and they do not need a cable for an internet connection. In order to support the this statistics, in the comparative statistics of TurkStat covering the years 2013-2023, the internet usage rate of young people is 98.4%. Based on this fact, we can argue that almost all of the young people who make up the population of Türkiye use the internet. Based on the report published by TurkStat, the ratio of the young population to the total population is 15.2%. In addition, it is reflected in the statistics that approximately 80 per cent of the young population is in the education age. According to TURKSTAT data, approximately 93% of the population in this age range attend educational institutions. The rate of students studying in higher education institutions is 29% as well.

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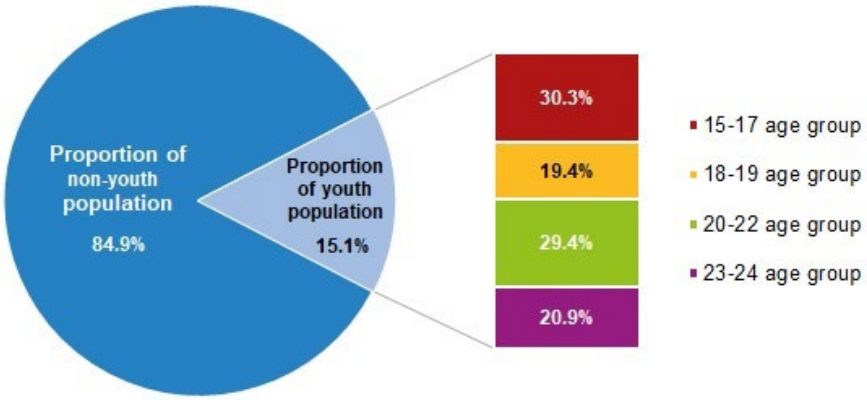
Figure 1

Proportion of Young Population by Age Group

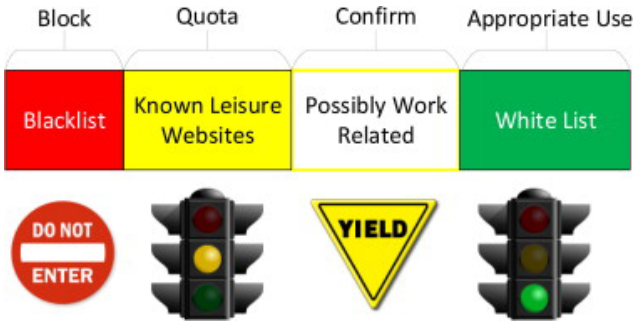


Based on all the statistics, graphs and tables shared above, we can say that portable devices, especially smartphones and tablets, are with users at all hours of the day and regardless of the environment. It provides 24/7 internet connection in a wide range from workplaces to public transport vehicles, from food and beverage venues to schools. This situation leads to uncontrollable internet usage and loss of efficiency by using these devices and the opportunities they provide during the time that should be allocated to daily routine tasks (education, work, social life, etc.). In workplaces, the use of devices/internet or personal devices and connections provided by the workplace during working hours outside of the work done limits employee productivity and affects motivation and work performance, and the reflection of a similar situation on schools negatively affects education and training activities. According to Kim and Byrne (2011), cyberloafing is the use of web access resulting from lack of self-control in work environments and regularly engaging in non-work-related activities. Rusiya and Tolani (2018) define cyberloafing as the misuse of the internet, an action that employees take by using the company's access during working time, such as exploring non-work-related websites and sending and receiving personal emails. The author states that this is a reaction to situations such as employees' perception that their employers are unfair and unfair wage deductions. In addition, although it is foreseen that low-wage and status employees exhibit cyberloafing behaviours, he argues that high-wage and status employees also exhibit this behaviour. Varol and Yıldırım (2019) state employees chatting outside of work for a short time next to the water cooler or coffee machine before the use of technology in workplaces and defined as "loafing", it has turned into "cyberloafing" in workplaces with the use of technology-intensive processes. In addition, he argues that technology-intensive processes are used not only in business life but also in education, and that similar behaviours of employees are also exhibited by students, and that this is achieved through the use of laptops in classrooms for different purposes such as taking notes, viewing course materials, doing research, playing games, sending instant messages, watching movies, etc. outside of the main element of the classroom environment. Based on this definition, it is thought that tablets and mobile phones should also be included in this definition as mobile devices become widespread and ergonomic, and it is suggested that not only laptops but also mobile devices such as mobile phones and tablets should be defined as cyberloafing. Information-intensive employees present cyberloafing behaviours more intensely, which is not in line with their work. Cyberloafing is an act of distraction (Lim & Chan, 2012). However, knowledge-intensive employees have to focus more on the task at hand (Aghaz & Sheikh 2016). At a copper mining and refining facility in Iran, 500 employees and managers were found to engage in cyber slacking behaviors such as visiting investment and banking websites, making online purchases and payments, and sending and receiving irrelevant emails (Sheikh at al., 2015). Buntarangin and Frantzen (2022), in their study on cyberloafing behaviours among employees in telecommuting processes, found that the degree of monitoring and restrictions imposed on employees by workplaces can possibly affect the degree of

cyberloafing, in addition, the characteristics of the work tasks imposed on employees can affect the degree of cyberloafing. Boredom and heavy workload were found to affect cyberloafing. Wang et al. (2023) found that the decreased sense of control that emerges on employees in the process of working from home encourages cyberloafing. Koch and Nafziger (2016) argue that unrestricted internet use at work triggers cyberloafing and that restricted internet use would be a more effective solution. On the other hand, Luo et al. (2022) argue that computer monitoring and internet usage policies can give inconsistent results in use, and this is due to ignoring personal differences. Glassman et al. (2015) propose a filtering system to prevent cyberloafing in workplaces. This system is blocked sites that the employee can never enter, which are also visualised with traffic signs and colouring. These sites are on the black list and users are not allowed to access them. On the other hand, the white list is a filtering system that does not impose any restrictions on the use of the internet by employees and allows access to all sites. Between these two extremes, from the whitelist to the blacklist, there are sites where the content of the site cannot be fully determined, but which are considered potentially work-related. It is a filtering method in which the user is asked about the nature of the site visit in the context of content approval. Finally, although it is known that it is not work-related, there is a filtering procedure that employees need motivation and can be characterised as a free space, but this can also be used within a certain quota.

Figure 2

Categorical Filtering



Rahimnia and Mazidi (2015) found that organisational control elements do not affect cyberloafing and only self-control has an effect on this behaviour. Wang et al. (2013) conducted a study with the participation of 209 Chinese civil servants to control cyberloafing behaviours in public institutions and found that internet usage policy is more effective on employees with higher self-esteem than employees with lower self-esteem, and electronic monitoring is more effective on employees with higher job satisfaction. Muthuswamy and Varshika (2023) conducted a study on 219 employees and found that electronic monitoring policies of organisations increase the performance of employees by reducing cyberloafing. Shekher and Joshi (2018) grouped cyberloafing into major and minor cyberloafing and emphasised that while actions such as sending and receiving personal e-mails are used to exemplify minor cyberloafing, major cyberloafing is more comprehensive processes such as online gambling and browsing adult websites. In addition, the positive and negative effects of cyberloafing and argued that while cyberloafing has negative consequences such as privacy issues, misuse of network resources and non-competitive organisation. Cyberloafing also has positive aspects that cannot be ignored as it reduces boredom and stress caused by working and helps to be creative and flexible. Employees who encounter the success/achievements of their colleagues on various social media platforms show cyberloafing behaviours as a result of the suitable environment for making negative comparisons (Chen et al., 2024). Durak and Saritepeci (2019) argue that although the wired and wireless internet connections provided for the interactive boards integrated into educational institutions and the education system with projects such as the FATİH project are not used for their intended purpose, cyberloafing behaviours are exhibited by overcoming the obstacles with VPN services. It has been

determined that the use of technological devices and the internet during classes by 274 undergraduate students attending a state university in the northeastern United States has an impact on cyber loafing and that students are prone to this behavior (Taneja at al., 2015). Ozdamlı and Ercag (2021) conducted a study on 150 university students studying in the Turkish Republic of Northern Cyprus and found that students engaged in cyberloafing during the course via mobile devices. A study conducted on a research group consisting of 1,339 students and 996 employees revealed that both groups used their own devices and data networks during class or working hours. This behavior can be considered cyber loafing as it is disruptive and inefficient (Akbulut at al., 2017). Baturay and Toker (2015) conducted a study on 282 high school students and found that male students cyberloaf more than female students, advanced expert users -which is stated to be 9 years of internet experience- exhibit more cyberloafing behaviour than novice and intermediate users. In addition, advanced and expert internet skills along with daily internet use cause cyberloafing. In his study on 143 students, Green (2019) found that when students are motivated, they use their mobile devices as a means of obtaining information and taking notes on class participation, access to course materials and discussion topics, and when educators cannot provide the necessary motivation, students exhibit cyberloafing behaviours. Marumpe et al. (2023) conducted a study on the cyberloafing behaviours of Tanjungpura University Faculty of Economics and Business Administration students and found that students' honesty and self-control prevented them from exhibiting cyberloafing behaviours. Derin and Gökçe (2016) conducted a study on 152 employees at Malatya İnönü University and suggested that managers should strike a balance between work efficiency and employee needs instead of struggling to completely eliminate cyberloafing. The misuse of smartphones in classroom environments negatively affects learning, triggers cyberloafing behaviours, and simultaneously increases smartphone addiction. Additionally, university students' cyberloafing behaviours negatively influence their feelings about the meaning of life. Based on these findings, appropriate measures should be taken to control and restrict internet use and to help reduce students' anxiety through guidance (Gökçearslan et al., 2016; Li et al., 2022). Şenel et al. (2019) revealed in their study among 124 university students that the biggest reason for cyberloafing is that students are reluctant to learn. Other reasons include receiving notifications on the phone and their desire to communicate, their sense of curiosity and their desire to spend time more fun. Tepe and Ergüney (2023) conducted a study among 222 university students and found that students performed cyberloafing actions with the dimensions of content access, sharing and gaming/betting. Bağrıaçık Yılmaz (2017) conducted a study on 168 graduate students and found that students mostly engage in cyberloafing through messaging activities, followed by social networking sites, personal interests and news sites. Çınar and Cinisli (2018) conducted a study on 112 university students and found that instant messaging came first in the ranking of students' cyberloafing behaviors, followed by visiting sports websites and talking on the phone in the third place. Sinap (2023) lists the reasons why 391 higher education students exhibit cyberloafing behavior in distance education as follows: (1) student-related reasons, (2) instructor-related reasons, (3) distance education-related reasons, and (4) other reasons. Ross (2018) approaches cyberloafing from the perspective of healthcare professionals and defines cyberloafing as an important risk for patient safety. Healthcare providers, who always carry their personal phones with them, check their personal e-mails, share social media posts and follow the posts during the day. Even referring to a news published in the New York Times, he argues that 55% of perfusionists use their mobile phones during the operation, which poses a great risk for patient safety.

This study was designed to determine the cyberloafing behaviours of Sakarya University students. cyberloafing is defined as the misuse of technology during and in the classroom, has negative effects on education and training activities. However, it would be insufficient to think and examine cyberloafing behaviours only with the student dimension. Although the basis of the behaviour in question is the students' use of technologies during the lesson and in the lesson environment, there are also various reasons that push them to this behaviour. In addition to the course durations and contents that will keep

the motivation of the students high, it is essential that the lecturers and instructors who are responsible for teaching the course carry out their educational activities by following methods that will not lead to this behaviour. Revealing the reasons that push Sakarya University students to cyberloafing behaviours is considered as the first condition for the solution of the problem. For this reason, this study was designed to focus on the causes of this emerging behaviour and to offer solutions to prevent this behaviour from being under control with what kind of measures, even if it cannot be completely prevented, to prevent it from being to the extent that it will disrupt educational activities. It is thought that the results and suggestions presented as the output of the study will benefit all stakeholders, especially educators and students involved in educational activities. It is thought that outputs such as determining the reasons that push students to cyber loafing, determining their sources (lack of interest in the course, attitude towards the course instructor, outdated course content, etc.), supporting stakeholders who need support in the context of the result, optimal use of resources, and the establishment of mentoring programmes will be an effective management, especially in terms of students.

2. Method

2.1. Research design

Quantitative research method was used in this study. Quantitative research method is a research tradition that focuses on the relationships and differences between variables and makes predictions for the future with the aim of generalization (Garip, 2023). The fact that the researcher aims to reach a large group of participants, wants to statistically analyze the data obtained and can generalize the results (Patton, 2014) requires the preference of quantitative research method. In addition, if it is aimed to verify the relationships between factors within the scope of the subject studied, to focus on the causes of human relations and to try to determine these causes (Büyüköztürk et al., 2016), quantitative research method will be appropriate. The convinient sampling method was used to select university students who constituted the quantitative dimension of the research. Hence, we have enhanced the reacheability of our sample and be able to include varitety of subjects from different schools and institution at Sakarya University. Sakarya University has a large student population and comprises individuals studying in various academic units from different geographical regions of Türkiye. The university includes faculties, vocational schools, and institutes, encompassing students from diverse academic disciplines. This diversity allows the study to be conducted on participants with different academic backgrounds, interests, and educational levels. Consequently, though the generalizability is still limited to university students, we can use the study's findings to a broader student population that would increase the validity of the obtained data in different contexts. The research group consists of students from Sakarya University. According to data obtained from the university's official website, the total student population at Sakarya University for the 2023-2024 academic year is 54,530. According to MacCallum and Widaman (1999), the sample size should be between 5 to 10 times the number of variables used in the study. The scale utilized in this study initially consisted of 30 items (including those removed due to insufficient factor loadings). After eliminating items that did not meet the factor loading criteria, the final number of items was reduced to 20. Based on MacCallum and Widaman’s study, the sample size in this research can be considered sufficient. The study includes students enrolled in Vocational Schools, Faculties, and Institutes. A convenience sampling method was employed. According to Golzar and Tajik (2022), convenience sampling allows data to be collected from the target population easily, quickly, and cost-effectively.

Table 1

Findings Related to Demographic Characteristics

		f	%			f	%
Gender	Female	151	43.9	Daily Time Spent on Social Networks	Less than hour	22	6.4
	Male	193	56.1		1-2 hours	92	26.7
Department	MIS	156	52		3-4 hours	132	38.4
	Economics	30	8.7		5-6 hours	72	20.9
	Buseiness	14	4.1		7 hours or more	26	7.6
	Econometrics	10	2.9	Device used when connecting to the Internet	Smartphone	252	73.2
Class	Preparation	2	0.6		Laptop	30	8.7
	Grade 1	122	35.5		Desktop	14	4.06
	Grade 2	100	29.1		Tablet	48	13.9
	Grade 3	35	10.2				
	Grade 4	85	24.7	Discipline	Social Sciences	269	%78.4
Lessons from Previous Periods	None	212	61.6		Natural Sciences	75	%21.6
	1-3	96	27.9				
	4-6	26	7.6				
	7-9	4	1.2				
	10+	6	1.7				

According to the data in Table 1, 151 of the students participating in the study are female and 193 are male. The students from the Department of Management Information Systems constitute the majority with 156 students, while 30 students from the Department of Economics, 14 students from the Department of Business and 10 students from the Department of Econometrics participated in the study. In addition, students from different faculties and departments of the university also participated in the study. Students from different departments participated in varying numbers. However, the table shows the departments and the number of students who participated the most. In addition, 269 students from the social sciences discipline and 75 students from the science discipline participated. 1st and 2nd year students are 122 and 100 respectively. In addition, 35 3rd year students and 85 4th year students participated in the study. The number of students who did not have any courses from previous semesters (from the bottom) was 212. There are 96 students between 1-3 courses and 26 students between 4-6 courses. 38.4% of the students participating in the study spend between 3-4 hours a day on social networks. While 20% of them spend between 5-6 hours, 7,6% of them spend 7 hours or more on social networks. One of the striking data here is the time students spend on social networks. A total of 66.9% of the students spend between 3 hours and 7 hours or more on social networks. It is possible that such long periods of time continue during class hours and naturally in the classroom environment. These data are even more meaningful when evaluated together with the device used by the students while going online. When the responses of the participants are analysed, it is observed that 73.2% of them use their smartphones and 13.9% use their tablet devices when going online. Considering the mobile functions of these devices, it is possible to use these devices for various legal excuses (taking notes, reviewing course materials, etc.) during the course and in the classroom environment.

2.2. Data collection tools

The data collection tool consists of four sections. In the first part, there are questions about the participants' gender, the department they are studying, their grade level, the courses they took in the previous semester, the devices they prefer to connect to the internet and the time they spend on social networks. In the second section, 7-point categorical variables were used to determine the reasons for using mobile devices during the course. Borgers et al. (2004) stated that the number of response alternatives has a nonlinear effect on scale reliability. Accordingly, an increase in the number of response alternatives enhances the reliability of the scale up to a certain point; however, beyond this

point, reliability begins to decline. Emphasized that the most optimal options for researchers are Likert-type scales with six or seven response alternatives. Besides, by incoporating 7 point Likert Scale, we were able to do fine tuned and more exact analysis in our study, which further enhanced our interpretations. In the third section, the "Cyberloafing Scale" was used. 7 point scales is only used in demographic questions to finly eleobared mobile phone checking habbits for all other teoritecal scales we used 5 point like scales as proposed by the authers. In the last part of the data collection form, a qualitative data collection question was asked to determine in detail the reasons why students use mobile devices during the lesson. The data of the study were collected with the Cyberloafing Scale prepared by Akbulut et al. (2016). In the statements in the scale, a 5-point Likert scale was used and designed to be in the range of 1- Strongly Disagree to 5- Strongly Agree. The scale consists of 5 factors and 30 statements. The factors are sharing, shopping, real-time update, access to online content and gaming/betting, respectively. The scale consisting of 5 factors and 30 statements was used in the study, but 10 of the statements were removed because they did not meet the factor loadings. In the original scale, the internal consistency coefficient (Cronbach's Alpha) was determined as 0.93 for sharing, 0.87 for shopping, 0.93 for real-time applications, 0.94 for online access, and 0.80 for gaming/gambling, while the overall scale had a reliability coefficient of 0.95. Exploratory Factor Analysis (EFA) was applied to confirm the factor structure of the scale and to test its validity in the sample in our study. EFA was preferred in order to explore the factor structures underlying the existing items and to determine which factors the statements in the scale were significantly grouped under. Although the scale has been developed previously, it is recommended that the factor structure be retested and its fit be reviewed in different samples and cultural contexts (Costello & Osborne, 2005). Based on the data obtained from the present study, the internal consistency coefficient (Cronbach's Alpha) was calculated as 0.834 for sharing, 0.857 for shopping, 0.885 for real-time applications, 0.741 for online access, and 0.836 for gaming/gambling, while the overall scale had a reliability coefficient of 0.884. According to Taber (2018), data with a Cronbach's Alpha value between 0.84 and 0.90 are reliable data. Based on this, it can be said that the data is reliable. Factor analysis was performed for the statements in the study and it was seen that the loads were collected in 5 items. The KMO value was found to be .844. According to Kaiser (1974), in the interpretation of KMO, values of 0.90 and above are considered excellent, values of 0.8 and above are considered high, values of 0.7 and above are considered moderate and mediocre, values of 0.5 and above are considered weak, and values of 0.5 and below are considered unacceptable. In the light of these data, it is concluded that the KMO value obtained is high.

2.3. Data collection

The data were collected between 08.06.2023 and 12.01.2024 with the ethics committee permission approved by the decision numbered "24" taken at the meeting of Sakarya University Social and Human Sciences Ethics Committee dated 07.06.2023 and numbered 58. The data collection tool was uploaded to an online platform (forms.google.com) and the link was shared with the pre-service teachers. Participants were informed about the content and purpose of the study and their consent was obtained before participating in the study.

2.3. Data analysis

In this study, which was prepared to examine the cyberloafing behaviors of Sakarya University students, SPSS 23.0 statistical program was used for data analysis. First of all, Kolmogorov-Smirnov and Shapiro-Wilk analyzes were performed to determine whether the data (game-betting, sharing, shopping, real-time application and online access) were normally distributed or not; as a result of the analyzes, it was determined that the data were not normally distributed (Table 2). Therefore, nonparametric tests were conducted.

Table 2

Distribution Analysis

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Betting	.299	344	.000	.705	344	.000
Sharing	.063	344	.002	.974	344	.000
Shopping	.192	344	.000	.902	344	.000
Real Time Apps	.118	344	.000	.925	344	.000
Online Access	.134	344	.000	.907	344	.000

Frequency was used to analyze the demographic characteristics of the students and the reasons for using phones during class. In addition, the averages of the reasons for using the mobile phone during the lesson were taken. In addition, students' responses to the statements were analyzed by factor analysis and the factors in which the statements were collected were determined. Then, Mann-Whitney U test was conducted to determine the relationships between the factors and the time spent on social networks, the grade they were in and the factors. Kruskal-Wallis H test was applied to analyze the relationships between the factors and the discipline, gender and whether or not they have taken lower courses. In addition, the chi-square test was applied for the relationship between gender and the time spent on social networks (Table 5).

3. Findings

In the Findings section, the inferences obtained as a result of the analysis of the data collected from the participants through the data collection form are shared.

Table 3

Reasons for Using the Mobile Phone During the Lesson

	Never		Occasionally		From time to time		Usually		Frequently		Most of the time		Always		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	$\bar{X}$
Doing research related to courses	32	9.3	73	21.2	96	27.9	59	17	36	10.5	28	8.1	20	6	3.5
Other	67	20	84	24.4	57	16.6	58	17	18	5.2	29	8.4	31	9	3.3
Messaging with friends	51	15	111	32.3	70	20.3	56	16	29	8.4	20	5.8	7	2	3
Boredom	69	20	114	33.1	74	21.5	36	11	19	5.5	15	4.4	17	5	2.8
Reading news from the internet	129	38	85	24.7	47	13.7	31	9	21	6.1	17	4.9	14	4	2.5
Lack of interest in the lessons	96	28	111	32.3	65	18.9	40	12	7	2	19	5.5	6	2	2.5
Desire to surf social networks	113	33	96	27.9	59	17.2	33	9.6	21	6.1	14	4.1	8	2	2.5
Negative attitude towards the lecturer	234	68	62	18	20	5.8	12	3.5	5	1.5	5	1.5	6	2	1.6

In Table 3, students use their mobile phones to do research about the lessons during the lesson. At this point, it is likely that students' spending time on their mobile phones, even if it is for doing research related the class, this may negatively affect the learning process of students. Students, researching a certain part of the subject or examples related to class they will miss the rest of the subject and the integrity will be disrupted as well. Instead of doing research about the course by themselves, it would be an effective method to try to solve the problem by talking to the course instructor. Here, it can be assumed that a cyberloafing behaviour has developed due to a judgement against the lecturer, but the low average of mobile phone usage behaviour during the lesson triggered by the negative attitude towards the lecturer makes this possibility not a strong alternative. Based on the assumption that cyber loafing behaviours such as looking at the clock, playing games, listening to music, family communication, messaging with friends, reading news from the internet are exhibited as a manifestation of boredom during the lesson, these actions may develop due to the fact that the lessons are not interesting.

Table 4

Distribution of Factor Loadings

	Sharing	Real-Time Apps	Shopping	Betting	Online Access	Mean	Std. Deviation	Cronbach's Alpha
I make status updates on social networks	0.792							
I mark my friends in the photos	0.747							
I share content such as photos and videos on social media	0.732					2.54	0.942	0.834
I comment on shared photos	0.709							
I check the social media profiles of my friends	0.534							
I check my friends' posts	0.523							
I retweet the tweets I like		0.853						
I add the tweets I like to favourites		0.852						
Tweeting		0.809				2.44	1.182	0.885
Reading tweets		0.789						
I comment on trending topics		0.564						
I visit online shopping sites			0.857					
I shop online			0.855					
I use online banking services			0.746			3.69	1.026	0.857
I visit sites that offer opportunities			0.719					
I visit betting sites				0.955				
I bet online				0.942		1.62	0.094	0.836
I check online sports sites				0.676				
Downloading video					0.847	2.77	1.357	0.741
Downloading music					0.804			

According to Table 4, the statements used in the data were grouped under 5 factors. These factors are betting, shopping, sharing, real-time applications and online access. There are 3 statements under the betting factor, 4 statements under the shopping factor, 6 statements under the sharing factor, 5 statements under the real-time applications factor, and 2 statements under the online access factor. While there are no hard and fast rules for the number of items to retain, there are some useful heuristics.

A measurement instrument is internally consistent and concise when it contains the minimum number of items that adequately cover the domain it is intended to assess (Hinkin et al., 1997). Statements that did not carry factor loads in the context of the scale used were removed from the analysis. At this point, 3 statements from the sharing factor, 3 statements under the shopping factor, 3 statements from the online access factor and 1 statement from the game/betting factor were not included in the analysis because they did not meet the criteria. Test values obtained as a result of factor analysis: Barttlett's test value p=0.000<0.05 and Kaiser-Meyer-Olkin sampling value 0.844, which is within the acceptance limits. The single factor obtained explains 68% of the total variance. When the internal validity of the factors are analysed, the betting factor has a mean value of ,836, the shopping factor has a mean value of ,857, the sharing factor has a mean value of 834, the real-time applications factor has a mean value of ,885, and the online access factor has a mean value of ,741.The averages of the sharing factor show that the participants' use of mobile phones during the course is to check their friends' posts. This action can be interpreted with FoMO (Fear of Missing Out), which has emerged in society in recent years, especially in the context of the development of technology. At the heart of the Fear of Missing Out is the desire to participate in pleasant and pleasurable experiences, the desire not to miss a discount or an invitation, in short, the tendency to be at the center of social interactions and relationships (Doğan & Yıldırım, 2024). Students are curious about the socialising of their friends while they are in class and what kind of activities they are involved in during this time. Again, based on the answers given by the participants, the lowest participation of the sharing factor can be considered as updating the status on social networks during the lesson. Considering that the likelihood of an activity that will attract attention and interaction on social networks during the course is low, the fact that students who check their friends' posts do not share can be evaluated from this perspective. The averages show that students exhibit cyberloafing behaviours by using online banking services during the course. Rather than using online banking services, which can be described as a short-term cyberloafing behaviour for reasons such as bill payment, checking account movements, monitoring investors, etc., the use of mobile phones during the lesson for online shopping is a more striking data. By its nature, shopping involves many processes such as comparison, selection and liking. Students' online shopping during class will not be considered as a short-term cyberloafing behaviour. Although they even buy the products they have previously added to the basket, they will carry out a new research, liking and preference process in case the stock status of the product they have added changes. This will prevent the information shared during the lesson from being learnt and prevent the education and training processes from achieving their goals. The averages of the real-time applications factor are included and it is noticeable from the participants' answers to the statements that they read tweets during the lesson. It is possible to evaluate this action in parallel with the action of checking the posts of their friends and to be curious about the developments in the outside world during the lesson and to satisfy this curiosity. In the averages of the online access factor, it is seen that students download music and videos during the lesson. It is possible to say that this action contains cyber security policy violations along with the negative effects of cyber loafing behaviour on the learning process. The use of unlicensed software from both personal and corporate internet connections plays a role that threatens cyber security. When cyber attack processes are examined, it is known that attackers infiltrate the systems of the victims with unlicensed software they offer to their victims and data theft is carried out. In addition to this, large-sized data downloaded using both corporate and personal internet connections create heavy traffic on the network and cause the network to slow down. The data belonging to the betting/gaming factor presents a worrying situation both during and after the lesson. The fact that online sports sites that provide data for students to play virtual betting/gaming are controlled by students during the lesson is a justified reason for this concern.

Table 5

Time Spent on Social Networks by Gender

Groups	Gender	Female	Male	Total	χ^2	df	p
Daily Time Spent on Social Networks	Less than 1 hour	5	17	22	14.325	4	.006
	1–2 hours	31	61	92			
	3–4 hours	61	71	132			
	5–6 hours	42	30	72			
	7 hours or more	12	14	26			
Total		151	193	344			

In the analysis, the relationship between the participants' gender and the amount of time they spent on social media daily was examined using the Pearson Chi-Square test. The results show that there is a statistically significant relationship between these two variables, $\chi^2(4) = 14.325$, p = ,006. Accordingly, a significant difference was observed between the time spent on social media by female and male participants. When examining the frequency distributions, it was observed that female participants used social media at higher rates in the 3–6 hour range, while male participants were more concentrated in the 1–4 hour range.

Table 6

Student's Class and Relationships between Factors

	Kruskal-Wallis H	df	p
Betting	2.639	4	.620
Sharing	6.082	4	.193
Shopping	1.415	4	.842
Real Time Apps	2.84	4	.585
Online Access	12.097	4	.017 *

Kruskal-Wallis H test was used to analyze the data in Table 6. Table 6 shows that there is a significant relationship between the class in which the students study and the online access factor. In other words, students exhibit cyberloafing behaviour to download videos and music during the lesson. Considering the grade level of the students, it is seen that 1st grade students exhibit this behaviour. Radical changes that occur in the student's life in a short time, such as the newly included institutional culture, course diversity, change in educator style and education model.

Table 7

Time Spent on Social Networks and Relationships between Factors

	Kruskal-Wallis H	df	p
Betting	0.360	2	.835
Sharing	24.394	2	.000 **
Shopping	1.403	2	.496
Real Time Apps	8.344	2	.015
Online Access	6.783	2	.034 *

Kruskal-Wallis H test was used to analyze the data in Table 7. Table 7 shows that there is a significant relationship between the time students spend on social networks and the factors of sharing, real-time applications and online access. As the time students spend on social networks increases, the frequency of cyberloafing behaviours also increases. It is seen that as the time students spend on social networks increases, they share, retweet the messages they like, add tweets to favorites, tweet, read tweets and comment on trending topics. In addition, it is also seen that they download videos and music.

Table 8

Relationships between Factors According to the Status of Taking Lower Courses- Discipline and Gender

		U	Z	p
Taking Lower Course				
	Betting	12093.5	-2.328	.020 *
	Sharing	13922.5	-0.078	.938
	Shopping	12962	-1.158	.247
	Real Time Apps	12755.5	-1.384	.166
	Online Access	12966	-1.157	.247
Discipline				
	Betting	9888	-0.095	.925
	Sharing	9392	-0.744	.457
	Shopping	7860.5	-2.793	.005 **
	Real Time Apps	9198	-1.004	.316
	Online Access	8168	-2.39	.017 *
Gender				
	Betting	10375.5	-5.041	< .001 ***
	Sharing	11039.5	-3.865	< .001 ***
	Shopping	10918	-4,025	< .001 ***
	Real Time Apps	12174.5	-2.63	.009 **
	Online Access	14281	-0.321	.748

Table 8 shows the relationships between the factors and the status of taking lower courses, departments and gender. When the participants' answers to the statements are analysed, it is observed that there is a significant relationship between the factors and whether the students have a lower course or not, only with the game-betting factor. Accordingly, it is seen that the game-bet factor is loaded more intensely by students with lower courses. The fact that students who failed in the previous semester/semesters exhibit cyberloafing behaviour by playing game-betting during the lesson instead of focusing on both their new courses and their courses from the previous semester/semesters and achieving the necessary success stands before us as an inference that should be taken into consideration. It is an important problem whether the course/lessons are not interesting for them or whether the negative thoughts brought against the lecturer are effective on their inability to focus or their preference for this. From another point of view, it is possible that the cyber loafing behaviors that they get into the habit from the very beginning may also be considered as a possible reason for this failure. Depending on the shopping factor, it is seen that students studying in social departments show more intense cyberloafing behaviors than those studying in science departments. At this point, we can infer that students studying in science departments direct their attention to the learning processes that are their real work in the course time and environments because their courses are based on more intensive practice/experimentation and these practices are often not possible to carry out practice/experiments outside of application areas and laboratories. On the other hand, it is thought that this judgement can be reached by referring to the statement in Table 2 that one of the reasons for using mobile phones during the lessons is that the lessons are boring, since the students studying in social sciences-oriented departments do not have an intensive application medium due to the nature of their departments and the lessons are mostly theoretical. The relationships between gender and factors are visible. According to the table in question, there is a significant relationship between gender and the other four factors except online interaction. In terms of factors, male students are dominant in the game-betting factor, while female participants are dominant in the sharing, shopping and real-time applications factors. While the cyberloafing behavior of male students during the course is playing games-betting, women exhibit behaviors such as sharing and shopping, tweeting, reading, adding to favorites, commenting on trending topics.

4. Discussion and Conclusion

This study, which was designed based on the question of how the concept of cyberloafing, which is one of the negativities that emerged with the conveniences provided by the changes in the possibilities of technology, affects education at the university level, tried to determine the attitude of university students to cyberloafing behavior. The findings of the study, which was created with Sakarya University students and ready-made scale limitations, are remarkable. First of all, it is seen that smart phones and then tablet computers are the devices that the students participating in the study connect to the internet. This output, which is in parallel with the cited statistics, graphs and tables, is evaluated based on the reasons that make cyberloafing behavior possible and difficult to control (personal, not being aware of its use under the desk or on the table due to its ergonomic design). In addition, when we look at the reasons put forward by students who use cell phones in class, details such as boredom, lack of interest in the lessons, texting with friends, looking at the time are noteworthy. This outcome of the study supports the research conducted by Taneja at al. (2015). In addition, the results are similar to the study conducted by Ozdamlı and Ercag (2021). In parallel with the results of the study conducted by Akbulut at al. (2017), it is seen that students exhibit cyberloafing behaviors. The act of exhibiting cyberloafing behavior in the context of gender revealed by the study differs from the study conducted by Baturay and Toker (2015). In the study in question, it was stated that male students exhibited more intense cyberloafing behavior than female students, while in the outputs of this study, it is seen that while male students' cyberloafing behavior during the lesson is playing games-betting, women exhibit behaviors such as sharing and shopping, tweeting, reading, adding to favorites, commenting on trending topics. Çınar and Cinisli (2018) also found that female students download more files such as music, software, and videos over the internet and shop more, which is similar to the data of this study. Considering and evaluating these reasons together will help in solving the problem. The fact that a student experiences boredom during the lesson, except for personal reasons, suggests that either his/her predisposition to the lesson is not sufficient or the ways and methods of teaching the lesson are not attractive to the student. In both cases, the necessary corrective efforts should be made to increase the student's predisposition and the instructor should update his/her methods to ensure the motivation of the students. The outcomes obtained at this point overlap with the studies conducted by Şenel et al. (2019) and Güngör (2021). Although negative attitude towards the instructor ranks last among the reasons for spending time with a cell phone in class, the existence of this possibility should not be overlooked. Green (2019) and İlhan and Önal (2024) argue that students do not exhibit cyberloafing behavior when they are motivated for the lesson, but they perform such an action in the opposite situation. When the results of the study are examined, it is seen that it coincides with this determination. It was also revealed that students share, use real-time applications, shop, bet and play games, and use applications that provide online access. This output is similar to the study conducted by Gökçearslan at al. (2016). Although all these actions pose a danger, especially betting and gaming behavior does not only threaten education and training activities, but also has the possibility of causing students to face bigger problems. Another striking finding in the study is the cyberloafing behaviors of science and social studies students. It was found that social studies students who participated in the research exhibited cyberloafing behaviors more frequently than science students. This difference is interpreted to be related to course content and processing. In the course content of science department students, a process of experimentation and application is followed, so active participation in the course is required, and the presence of experiments and applications prevents students from cyberloafing behavior. From the perspective of social departments, the absence of such experiments and applications causes students to lose their motivation and attention in the course and exhibit cyberloafing behaviors. These outcomes are similar to the studies conducted by Gülnar and Ünsal (2020) and Tatlı and Sadık (2021). Considering that this study was conducted among Sakarya University students, expanding the participation in the context of all universities will support the diversity of results and data and will allow more general comments and

judgments to be made. If the course instructors conduct education and training activities with more creative techniques and methods, it will eliminate the reasons such as boredom and lack of interest in the course, which emerged during the course and were also included in the data of the research. In particular, it would be beneficial for social departments to update their course content in a similar way, although not with experiments and applications as in science departments, and to evolve to a method based on student participation. Although USOM stops the access of websites labeled as illegal for cyber security purposes from within the country, this obstacle can be overcome with VPN applications. Preventing illegal access for individual use by preventing the access, download and installation of these applications would be a supportive measure. In corporate use, firewall devices in the network backbone fulfill this task.

In addition, in the light of the findings obtained from the study, a process can be developed and monitored within the framework of the following recommendations. These recommendations include a combination of various strategies to reduce cyberloafing behaviors in the university environment. It is important to tailor each recommendation to the needs of the students and the resources of the institution.

5. Recommendations

Internet Access Controls and Filtering Systems: Universities can install more sophisticated filtering and monitoring systems to control student internet use. In addition to preventing students from accessing harmful content, these systems can also be used to limit internet use during non-academic hours. For example, access to non-educational sites could be banned during certain time zones. In addition, internet usage data should be monitored regularly and students should be educated on cybersecurity habits.

Strengthening Technology Use Policies: Universities can review their technology use policies for students and set stricter rules. These rules can provide guidance on how students should use internet resources, especially outside of class. For example, it is important for faculty members to set a clear policy on the use of mobile devices during lectures and clearly communicate this policy to students. Furthermore, these policies need to be continuously updated to make students' internet usage habits more responsible.

Internal Audit and Feedback Mechanisms: Universities can regularly assess students' cybersecurity habits by establishing internal audit mechanisms to monitor digital behavior. These mechanisms can provide individual feedback to students to help them improve their digital habits. For example, at the end of each semester, students' internet usage habits can be assessed and feedback can be provided at both individual and community levels. This would encourage students to become more careful and responsible digital citizens.

Mentoring Programs and Digital Ethics Training: Upperclassmen or alumni can mentor incoming students on digital ethics and safety. These mentoring programs can be an effective tool to teach students how to use the internet more responsibly. In addition, cybersecurity awareness-raising seminars can be organized within these programs to help students use their time online more efficiently.

Behavioral Change Programs: Psychology or communication faculties can develop behavioral change programs for students to change their cybersecurity habits. Such programs can help students analyze their digital habits and avoid negative behaviors. For example, offering psychological counseling services can intervene in students' problems that may be related to attention deficit or excessive internet use. In such a program, strategies can be suggested for students to reduce their cyberloafing behaviors.

Suggestions for Future Research: By expanding the scope of this research, similar analyses can be conducted in different educational institutions. In particular, research conducted by independent

organizations or the Council of Higher Education (YÖK) to externally evaluate the relationship between university faculty members and students may help to obtain more objective results. Such research would provide a more objective understanding of students' attitudes towards faculty members.

These recommendations aim to take concrete steps towards more effective mitigation of cyberloafing behaviors in the university environment. Such practices will strengthen universities' digital security strategies and encourage students to use the internet more efficiently and ethically.

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