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Aim & Scope

Sakarya University Journal of Education (SUJE) aims to be a scientific source of reference in which academicians studying on educational sciences and teacher training field can publish their studies, and also they have access to related studies. The main aim of the journal is to increase and disseminate the literature in educational sciences and teacher training field.

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Reflective Thinking in The Problem-Solving Process: A Model Proposal

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Abstract

Problem solving is one of the basic skills that individuals need in a lot of fields throughout their lives. Problem solving is among the process standards in mathematics education; mathematics education aims to develop students' problem-solving skills in teaching all content domains. Reflective thinking is an important skill that directly affects problem solving and ensures its successful outcome. This research aims to determine the reflective thinking skills used in problem-solving and to model this process. The research was conducted as a case study, and the participants were selected using criterion sampling. Twenty pre-service primary teachers with different mathematics achievements participated in the study. Data collection tools are worksheets, think-aloud protocol, and semi-structured interview forms. In order to determine the reflective thinking skills used in problem-solving, a non-routine problem was solved by pre-service teachers in the worksheets through the think-aloud protocol and interviews were conducted with pre-service teachers. The data were analyzed considering the components and indicators of reflective thinking. The research results showed that the components of reflective thinking were used in all the problem-solving stages. Based on this result, a model proposal was developed regarding the problem solving process in which reflective thinking is used, and the results were discussed in light of the relevant literature.

Keywords

Problem-solving, reflective problem-solving, reflective thinking, components of reflective thinking.

Ethics Committee Approval: Ethics committee permission for this study was obtained from Ondokuz Mayıs University Social and Human Sciences Research Ethics Committee with the decision dated 26.11.2021 and numbered 11/2021-930.

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INTRODUCTION

Problem-solving is one of the critical skills that children need throughout their lives (Haylock & Cockburn, 2014). Developing problem-solving skills is one of the objectives of the mathematics curriculum in formal education (Ministry of National Education [MNE], 2018). Because, there is a general acceptance that students should be trained as skilled problem solvers through mathematics education (National Council of Teachers of Mathematics [NCTM], 1980; Schoenfeld, 1992; Van de Walle, Karp & Bay-Williams, 2014). Therefore, in mathematics education, mathematical concepts should be taught to students through problem situations based on real-life contexts so that they can transfer their mathematical knowledge and concepts to real life and solve these problems (Schoenfeld, 1992; Van de Walle et al., 2014). Like Gagne, many psychologists and educators see problem-solving as the most important learning achievement in life (Jonassen, 2000).

While solving a problem, students perform different cognitive actions; such as understanding the problem statement, selecting the necessary data for the solution, applying concepts and operations to the solution, solving the problem, and deciding whether the solution is correct. These actions contribute to the student's cognitive development (Bernardo, 1999; Charles, 1985). Because with problem-solving, children are taught not only the rules and strategies specific to the subject but also ways of thinking and approaches that can be used to develop a rule, formula, and self-learning strategies (Donnelly & Fitzmaurice, 2005; NCTM, 2000; Olkun & Toluk Uçar, 2012). Besides, problem-solving includes high-level mental skills such as critical thinking, reflective thinking, decision-making, and questioning (Demirel, 2002). In this process, students gain ways of thinking, curiosity, and confidence that they can use in situations they encounter outside of school and overcome difficulties. Therefore, problem-solving should become a lifestyle for students (Altun, 2014; NCTM, 2000).

The Stages of Problem Solving

Different models have been proposed in the literature on the stages of problem-solving. The first of these belongs to Dewey (1910). Dewey (1910, p. 72) explained five stages of problem-solving: "a felt difficulty, its location and definition, suggestion of possible solution, development by the reasoning of the bearings of the suggestion, and further observation and experiment leading to its acceptance or rejection." The famous mathematician George Polya (1945) developed the most known problem-solving model. He listed problem-solving stages as understanding the problem, devising a plan, carrying out the plan, and looking back. Polya's problem-solving model is dynamic. While determining a strategy, the student can reread it, thinking he did not understand the problem. He can go back to devising a plan or implementing the plan while evaluating the solution; can make a new plan, or try a different method for the solution. These stages are as follows (Altun, 2014; Baykul, 2011; Polya, 1945; Van de Walle et al., 2014):

1. Understanding the problem: In this stage, it is essential to understand the information given in the problem. This stage includes determining what is given and requested in the problem and summarizing it. The student reads the problem and explains it in his own words.

2. Devising a plan: The student thinks about how to solve the problem. The relationships between what is given and what is requested are investigated. He determines how to solve the problem. It includes actions such as making a plan for the solution, benefiting from the solution of a similar problem that has been solved before, determining the relations, and dividing the problem into sub-stages.

3. Carrying out the plan: At this stage, the student solves the problem by using the methods determined before. He carries out the plan, constructs mathematical sentences, performs the operations in order, and tries to reach the result.

4. Looking back: The student checks the result to determine whether it is correct. Looking back is a critical step in the problem-solving process, but many students overlook it when they reach the answer in the third stage. According to Polya (1945), at this stage, the student examines the problem-solving stages from beginning to end and explains why the strategy was successful or unsuccessful. He identifies the situations that work and those that do not in the problem-solving process. Therefore, this stage provides the student with essential experiences for future problem-solving situations.

The problem-solving models proposed by Dewey (1910) and Polya (1945) formed the basis of many models developed after them (Rott, Specht & Knipping, 2021). Schoenfeld (1982) developed a different model with the stages of analysis, design, exploration, implementation, and verification. Mason, Burton, and Stacey (1982) proposed a problem-solving model of three stages. This model consists of entry, attack, and review stages. Unlike other researchers, Wilson, Fernandez, and Hadaway (1993) emphasized the importance of the managerial process in problem-solving. They developed a problem-solving model consisting of understanding the problem, devising a plan, carrying out the plan, looking back, problem-posing, and managerial process. A different approach belongs to Haylock and Cockburn (2014). They defined three components of problem-solving as givens-goal-gap. They described problem-solving as closing the gap between the given and the goal. This gap starts with understanding what is given, and sometimes by working forward from what is given, sometimes by going backward from the goal, and sometimes by using both, working back and forth; this gap ends, and the problem is solved (Haylock & Cockburn, 2014).

What is Reflective Thinking?

For Dewey (1933, p. 3), the creator of the concept of reflective thinking, “reflective thinking is a thought process that involves turning a subject over in mind and giving it serious and consecutive consideration.” Rodgers (2002) summarized Dewey's thoughts on reflective thinking in four main points:

1. Reflection is a meaning-making process that enables the learner to more deeply understand the relationships and connections of their experiences with other experiences and ideas. It makes the continuity of learning possible and enables the individual's and society's progress.

2. Reflection is a systematic, rigorous, disciplined way of thinking rooted in scientific research.

3. Reflection must take place in society, in interaction with others.

4. Reflection requires attitudes that value the personal and intellectual development of oneself and others.

Reflective thinking includes rethinking and evaluating past events and experiences to obtain better and more efficient solutions in the future (Buzdar & Akhtar, 2013). Reflection is a way of correcting mistakes in people's actions and decisions to fulfill a task, but it also allows people to examine the assumptions they use to make sense of the world (Mezirow, 1990, 1991). This way of thinking does not arise spontaneously in daily life because it is a conscious mental activity. It occurs due to active effort; it is epigenetic (hereditary but not genetic) and needs to be learned and encouraged (Gelter, 2003).

Problem Solving and Reflective Thinking

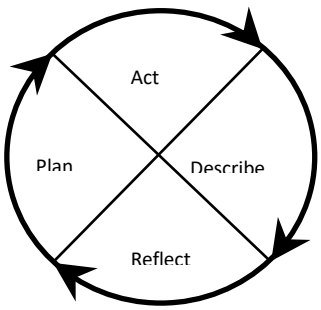
Reflective thinking is an important factor in problem-solving and mathematics achievement (Baş & Kıvılcım, 2013; Hong & Choi, 2011; Lai & Land, 2009) because it is one of the essential elements of problem-solving (Mason, 2009). Reflective thinking can be best observed in problem-solving because it allows the evaluation of the solutions put forward for the problem and selecting the best solution (Bingham, 2004; Shermis, 1992). According to Schön (1987), reflective thinking occurs when unexpected or unusual results in problem-solving conflict with one's knowledge. In such an imbalance, the person focuses on the situation and applies reflection to address the problem. Therefore, Schön (1987) considers reflection as a conversation between the problem solver and the problematic situation.

Hong and Choi (2011, p. 689) defined reflective thinking in the context of design problems as "conscious mental activities that examine designers' courses of action, decisions, and their inner selves in given situations throughout a design process." For them, associating the task in the problem with previous knowledge, skills and experiences is possible by reflecting on problem-solving. It also lets to determine the mistakes made in this process (Hong & Choi, 2011; Mason, 2009). This reflection increases students' learning experiences rather than memorizing theoretical formulas (Schön, 1987). It also supports the development of students' thinking and reasoning skills (Epstein, 2003). There is a strong and significant positive relationship between mathematics achievement, reflective thinking toward problem-solving, and metacognitive awareness (Toraman, Orakcı, & Aktan, 2020). In addition, reflective thinking toward problem-solving significantly predicts students' academic success in mathematics and geometry courses (Baş & Kıvılcım, 2013). Therefore, it is crucial to develop the reflective thinking skills of students while solving problems in mathematics lessons.

In the literature, studies are carried out on reflective thinking types, stages, and realization times. Schön (1987) expressed two types of reflection: reflection in action and reflection on action. "Reflection in action" is the reflection that emerges during the realization of the action, focuses on solving the problem, and rearranges the action. "Reflecting on action" is evaluating the action after the action has taken place, looking back, and thinking about the action deliberately and systematically (Schön, 1987). According to Tripp (2003, p. 10), reflection is a "conscious attempt to evaluate the process and outcomes of the action as experienced by the actor." It consists of plan, act, describe, and reflect stages. Tripp (2003) defined the stages of reflective thinking with the reflective practice cycle. Figure 1 shows Tripp's (2003)'s reflective practice cycle.

Figure 1

Reflective Practice Cycle (Tripp, 2003)



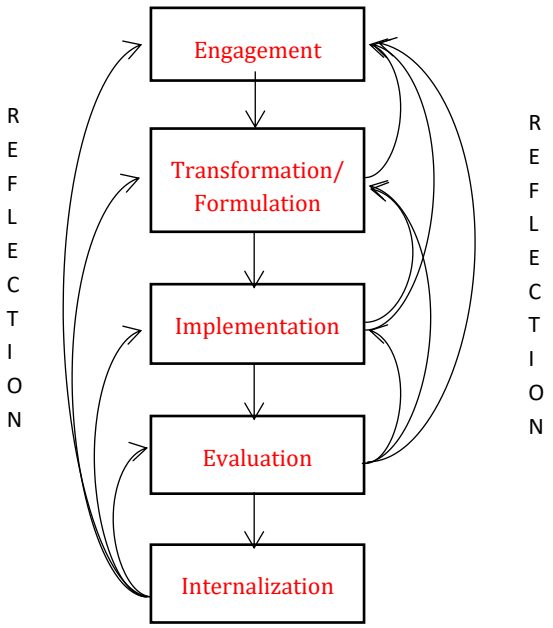
Tripp (2003) also determined the realization time of reflective thinking in problem-solving. Reflective thinking is planned simultaneously with searching for a solution to the problem in the "plan" stage. Reflective thinking occurs while the plan is implemented for the solution. Then the results are evaluated and reflected. This process continues in a loop. Developing reflective thinking skills is possible by being more conscious in the planning and monitoring stages of the action, reflecting on the action in the evaluation stage, and reviewing the reflective thinking processes (Tripp, 2003).

Kızılkaya and Aşkar (2009) mention three types of actions in the reflective problem-solving process. The first is questioning which seeks answers to questions produced by the person or directed to him from the outside. The other is evaluation; the person is looking back at his action and determining what is right and wrong. The last one is reasoning which involves investigating the cause of one's actions and examining cause-effect relationships according to the result.

Yimer and Ellerton (2010), on the other hand, proposed a five-stage model to describe the cognitive and metacognitive skills that pre-service teachers use in non-routine mathematical problem-solving. Researchers also examined pre-service teachers' reflections and modeled in Figure 2.

Figure 2

The problem-solving model of Yimer and Ellerton (2010)



On the other hand, Hong and Choi (2011) explained the reflective thinking used in design problems with a three-dimensional model. According to this model, three critical dimensions are level, timing, and objects of reflection. Timing is the model's first dimension and has two types: problem-driven and solution-driven approaches. The second dimension consists of the objects of reflective thinking, and the third dimension is the level of reflection. In a different study, Kholid, Sa'dijah, Hidayanto, and Permadi (2020) examined the reflective thinking skills of pre-service mathematics teachers in the problem-solving process. The research results revealed three types of reflective thinking components in terms of coping with the difficulty in the problem: assumptive, virtual, and connective. Another

result of this study is that the participants used all reflective thinking components in problem-solving, even if not at the maximum level.

Components of reflective thinking have also been investigated in other studies. According to Zehavi and Mann (2005), reflective thinking comprises techniques, monitoring, insight, and conceptualization. Techniques is concerned with how an individual uses techniques and strategies to solve a mathematical problem using effective principles. Monitoring is an activity used to monitor the solution of math problems. It refers to the individual checking whether the solution to a mathematical problem is correct. Insight is how an individual uses his intellectual and emotions to solve problems when he fails. Conceptualization is the component related to how an individual uses his ability to develop and understand concepts, analyze information and apply the solution to a problem (Zehavi & Mann, 2005). Besides, in different studies, it has been determined that reflective thinking has indicators such as doing something based on a plan, improving the level of knowledge, self-monitoring, and providing reasonable evidence to decide on a problem (Dervent, 2015; Ghanizadeh, 2017; Gencel & Saracaloğlu, 2018; Hsieh & Chen, 2012; Rieger, Radcliffe & Doepker, 2013; Sivaci, 2017; Satjatam, Sarintip & Teerachai, 2016). However, it was observed that there is a gap in the literature about modeling the reflective problem-solving process.

Aim of The Study

This research examines the reflective thinking skills used in the problem-solving and aims to model this process. The sub-problems of the research can be expressed as follows:

1. What are the reflective thinking components used in the problem-solving process?

2. How can the reflective problem-solving process be modeled?

METHOD

A case study, one of the qualitative research designs, was used in the study. The case study is a type of research in which a single individual, group, or important subject is comprehensively examined and studied (Fraenkel, Wallen, & Hyun, 2012). In the study, the reflective thinking skills used by pre-service teachers while solving a non-routine problem were examined in detail.

Participants

The research was conducted in the Faculty of Education of a university in North Anatolia in the fall semester of the 2021-2022 academic year. Twenty pre-service teachers from different grade levels studying in the Department of Primary Education participated in the research. Participants were selected among volunteer pre-service teachers using the criterion sampling method. The pre-service teachers from high, medium, and low success levels participated in the study, taking into account the achievement scores of the Basic Mathematics course. Thus, it was aimed to examine the reflective thinking skills used by pre-service teachers of all achievement levels. Seventeen participants are female, and three are male.

Data Collection Tools

The data collection tools are worksheets, think-aloud protocol, and semi-structured interview forms.

Worksheets: In order to determine the reflective thinking skills used by pre-service teachers in the problem-solving process, a non-routine mathematical problem was asked to them in the worksheets.

According to Kitchener and Fischer (1990), well-structured problems can be solved with a "high degree of certainty"; the problem's parameters are known, and there is only one correct answer that can be verified by the appropriate use of an algorithm, formula, or procedure. However, non-routine problems cannot be defined precisely. Real-life problems of this type have unknown parameters. The reasoning required to propose reasonable solutions for such problems is similar to what Dewey describes as reflective thinking (Kitchener & Fischer, 1990). Although different researchers have developed many models for problem-solving stages, the most widely known was developed by Polya (1945). Therefore, the reflective thinking components used in the problem-solving stages of Polya were examined in the research and the worksheets were organized according to Polya's problem-solving stages. Two lecturers from mathematics education and primary education examined the problem. Afterward, a pilot study was conducted with a randomly selected group of pre-service teachers, and the worksheet was revised based on feedbacks.

Think Aloud Protocol: A thinking-aloud protocol was applied to determine the reflective thinking skills used in the problem-solving process. The think-aloud protocol is a verbal performance-based assessment technique in which participants state aloud everything they thought and did while performing a given task (such as reading a verbal text or solving a math problem) (Özkubat & Özmen, 2018; Rosenzweig et al., 2011). Before applying the think-aloud protocol, participants were trained about thinking aloud. The think-aloud protocol directive at the worksheet was also explained to them (Özkubat & Özmen, 2018):

“You have to solve this problem by thinking aloud. You should audibly explain everything that comes to your mind, your thoughts, and the reasons for all your procedures. How you solve the problem is more important than the outcome. That is why you need to explain how you think about the solution. This worksheet was organized according to Polya's problem-solving stages. It would be best if you expressed aloud what comes to your mind at each stage. In order to analyze this whole process, I need to record your voice with this voice recorder."

Semi-Structured Interview Form: A semi-structured interview form was also applied to pre-service teachers, and interview questions were asked to better reveal their reflective thinking skills. For example, at the stage of understanding the problem, some pre-service teachers read the problem and started to solve it. In order to determine their reflective thinking skills, the interview question of "what other methods do you use to understand the problem?" was asked to them. Some pre-service teachers skipped looking back stage after solving the problem. At this stage, the following questions were also asked to them:

“How would you evaluate the results after solving the problem? How do you check the correctness of the solution? What methods do you use? What will you do if the result is wrong?”

Applications

In the applications, the purpose of the study was explained first. Then the implementation of the think-aloud protocol was expressed to participants. It was requested that they solve the problem according to Polya's problem-solving stages and they explain their thoughts, procedures, and reasons at each stage aloud. The applications were conducted with each pre-service teacher in the researcher's office. The applications were started by saying, "I want you to solve the problem by thinking aloud," and when they were silent, they were asked, “What do you think now?” or “Can you please think aloud?” In each stage of the solution, interview questions were also asked. Each implementation lasted an average of 25-30 minutes and was recorded with a voice recorder.

Data Analysis

The data obtained from the audio recordings of the think-aloud protocols, interviews, and worksheets were analyzed and interpreted together for in-depth analysis. The data analysis steps suggested by Özkubat and Özmen (2018) were followed in the analysis of the think-aloud protocol and interviews. These steps are analyzing the qualitative data and transforming it into quantitative by recording them in the Think Aloud Protocol Coding Form. The audio recordings were transcribed on the computer. Reflective thinking components and indicators suggested by Kholid et al. (2020) were taken into account in the analysis of the transcripts. Kholid et al. (2020) identified indicators and components of reflective thinking suggested by Zehavi and Mann (2005) in their study. These components are presented in Table 1.

Table 1

Reflective Thinking Components and Indicators (adapted from Kholid et al., 2020)

Components	Indicators	Codes
Techniques	1. Finding how to understand what the given question means	T1
	2. Finding how to understand what the question is	T2
	3. Inferring the question's meaning	T3
Monitoring	1. Monitoring the steps of the solution to mathematics questions	M1
	2. Monitoring whether the answers are correct or not	M2
	3. Using strategies for solving the questions	M3
Insight	1. Being ready to correct the wrong questions	I1
	2. Understanding how to prevent any difficulty	I2
Conceptualization	1. Thinking about other ways of solving the questions	C1
	2. Relating relevant concepts to solving the questions	C2

The reflective thinking components used in the problem-solving stages were coded considering the indicators in Table 1. The codes were recorded in the coding form, and total frequencies were calculated. Besides, the findings included examples from the worksheets, and direct quotations from the pre-service teachers' views. Pre-service teachers were coded according to their gender and mathematics achievement. For example, PT1FM refers to the first female pre-service teacher with moderate mathematics achievement. PT2MH refers to the number 2 male pre-service teacher with a high mathematics achievement level.

Validity and Reliability of the Research

In qualitative research, validity is divided into internal and external (Guba & Lincoln, 1982). To ensure the credibility of the study within the scope of internal validity, data were collected by triangulation (worksheets, think-aloud protocol, and interviews). For external validity (transferability), the participants were selected according to the criterion sampling method, one of the purposive sampling methods. The inclusion criterion in the sampling was also specified. In addition, the applications and participants within the scope of the research were described in detail. For the reliability of the data analysis, the codings were presented to a lecturer in mathematics education. The lecturer examined the analysis of the transcripts according to the indicators in Table 1. Then, the differences were determined, and the codings were corrected by exchanging ideas between the lecturer and the

researcher. This way, the data analysis ended after all the codings were examined and arranged in consensus.

Ethical Principles

Ethical principles were complied with during the implementation of the research. Ethics committee permission for this study was obtained from Ondokuz Mayıs University Social and Human Sciences Research Ethics Committee with the decision dated 26.11.2021 and numbered 11/2021-930.

FINDINGS

Reflective thinking components used in the problem-solving process

The components of reflective thinking used in the problem-solving process were analyzed and the results were presented in Table 2.

Table 2

Reflective thinking components used in the problem-solving process

	Reflective thinking components and indicators	f	%
Understanding the problem	Techniques T1, T2, T3	20	17,54
	Insight I2	4	3,51
	Conceptualization C2	5	4,39
Devising a plan	Monitoring M1	6	5,26
	Insight I2	4	3,51
	Conceptualization C2	9	7,89
Carrying out the plan	Monitoring M1, M3	14	12,28
	Insight I2	6	5,26
	Conceptualization C2	5	4,39
Looking back	Monitoring M1, M2	12	10,53
	Insight I1, I2	14	12,28
	Conceptualization C1	15	13,16
Total		114	100

Table 2 shows the components of reflective thinking used in problem-solving, and it is seen that the components are used in all problem-solving stages. An example of the T1 indicator of the Techniques component is so: *"I try to use a few variables to understand and solve the problem. For example, instead of x and y, I just use only x. Instead of x + y = 15, I would say y=15-x. So much unknown confuses me"* (PT19MM). Another indicator of the Techniques component is: *"If the question is long, I write what is given. If it is short, it is not necessary. However, if it is long, I forget what is given. I read the question one by one to understand better. For example, I reviewed it again since this question has a lot of data. I concretize the question in my head. I think about why it is given and what is asked for by writing it down on paper. On the one hand, I am thinking about how to solve this. I think how to understand, follow a solution, and perceive it more easily"* (PT4FH). A different view of this component is, *"After reading and understanding for the first time, I read and start solving for the second time. Because I know what is coming, I will try to find the price for 1 GB. I need to find the fixed fee. Let's call*

the fixed fee x. I understood the problem. However, I need to set a fixed fee. I doubted there. Should I say x to fixed fee? Should I say x to 1 GB? I could not decide. That is why I am rereading it." (PT13FM).

Table 2 shows that the Monitoring, Insight, and Conceptualization components are used in the problem-solving stages of devising a plan, carrying out the plan, and looking back, although their indicators differ. A statement containing both the Monitoring and Conceptualization components says: *"To solve the question, I first read the order of operations; I think about why I am doing it. I do not do anything without thinking about the question. I think about the relationships between the givens. I do not do random procedures. There is a sequence of actions; I predict the next action."* (PT3FL). Here is an example of the M2 indicator of the Monitoring component: *"I am evaluating the result. Here I will find the person using 30 GB per month. I said x to that. I found that y is three and x is 30. He paid 75 liras in total. It confirmed the result; it is true."* (PT8FH). Some of the views on M3 were expressed as follows: *"Now I am reading aloud. However, when I read it out loud, I do not understand. I understand when I read it silently. I usually understand all the questions the first time I read them. I read with attention to numbers. For example, when I first read this question, I put 15 GB in my mind"* (PT2FL). *"When I first read, I read numerical data by writing. If the question is easy, I understand it in the first reading. Sometimes I have to reread the hard questions"* (PT8FH).

As a result of data analysis, it was determined that the Insight and Conceptualization components of reflective thinking are used in all problem-solving stages. An example of the I1 indicator of the Insight component is, *"I will now check the result I found. I made a mistake; now I am doing it again. Yes, I made a mistake here; I am correcting it. This time, I am verifying the result. I have been checking from the beginning. Was there a transaction error? I am looking at the numbers, division, and proportions. I got 400. I will recheck this by dividing it. The answer has changed. I had found 35 before. When I checked, I found 33 this time"* (PT5FM). A view of both the Insight and the Conceptualization components is: *"When I read the problem first, I think about how to solve it. What is already given is in the form of a continuation of each other. I make a connection between what was given. Why was it given? How do I find the ones that are not given? I try to pick the ones that work for me"* (PT15FH).

An example of the C1 indicator of the Conceptualization component was expressed as: *"After solving the problem, I do not try many different ways. If the answer is correct, I continue. However, if the solution is too long, I think about a different way. I think there must be a shorter solution."* (PT19MM). Another example of the C2 indicator is *"While reading the question, at the same time I think about how to do it by relating the givens, a solution is formed in my head."* (PT2FL).

The model of the reflective problem-solving process

Table 2 shows that reflective thinking emerged in all stages of problem-solving. This process was modeled in Figure 3.

Figure 3

Model of the problem-solving process, including reflective thinking

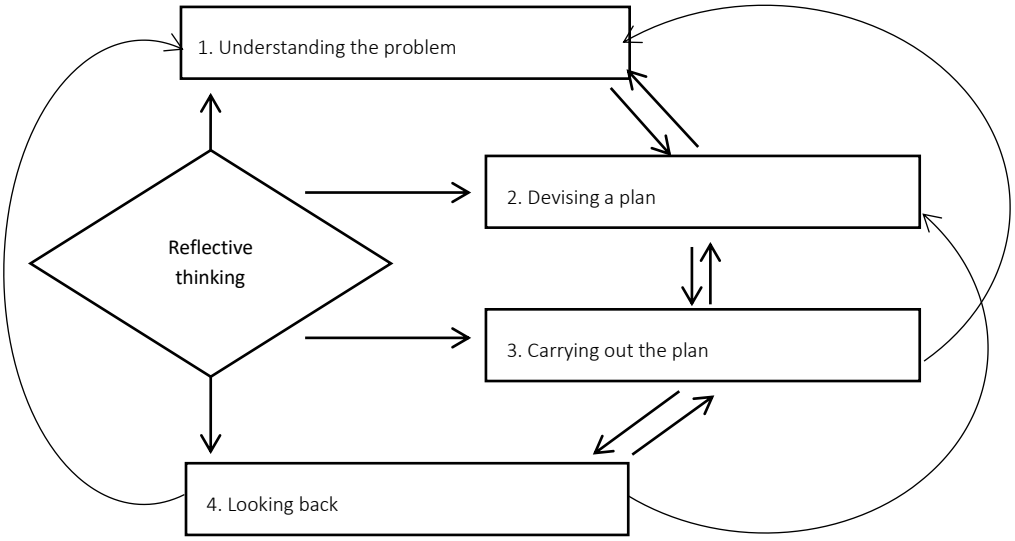
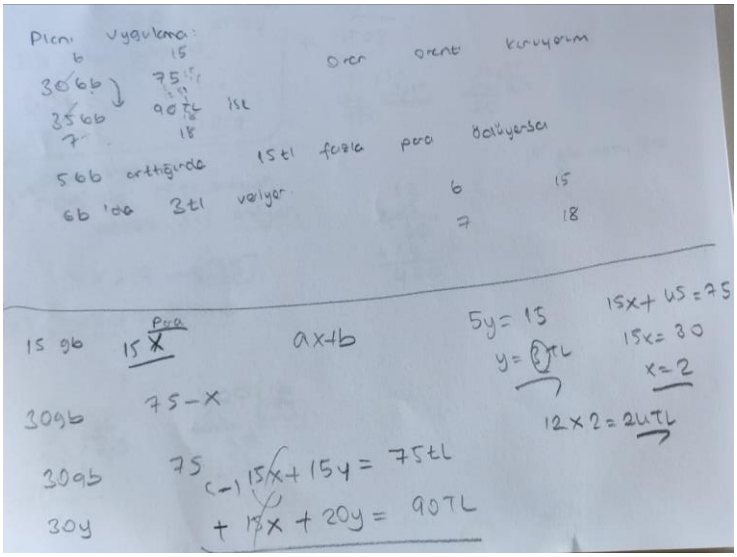


Figure 3 shows the modeling of the problem-solving process that includes reflective thinking. During the applications, the transitions of the pre-service teachers between the stages of problem-solving were represented by arrows in the model. The pre-service teachers started problem-solving by reading the problem and continued by making a plan for the solution. Then, the planned solution was implemented, and the correctness of the solution was tested. Besides, some pre-service teachers reread it, thinking that they did not understand the problem while planning the solution: *"Now I am rereading the question, I am trying to understand how many GB was given in the beginning, I am trying to understand it again, I realized that I did not understand it"* (PT19MM). Some pre-service teachers returned to the previous stage, devised a plan again, and changed the solution path when they could not reach the result: *"There is no result; I think I need to try a different way"* (PT11FL). In addition, when the pre-service teachers understood that the result was incorrect in the looking back stage, they tried to reach the right solution by checking all the stages respectively: *"Sometimes I make many transaction errors. If the result is wrong, I delete all the transactions and do it again. Sometimes I misunderstand the question. I am trying to read and understand the question again. I need to check it"* (PT12MH). In this problem-solving process, reflective thinking emerged as a skill that guides all stages. It was observed that the pre-service teachers, who could not reach the correct result, clearly used reflective thinking skills. When the result was wrong, they stated that they returned to the previous stages in order, sought the cause of the error, and tried to reach the correct result; *"I put the numbers to try if the answer is correct. It should give a total of 90. It is true. However, I would go back to the beginning if it was wrong. I would check transactions first. If there were no transaction errors, I would reread it. I probably thought I did not understand the question"* (PT19MM). In Figure 4, a worksheet belonging to a pre-service teacher is presented.

Figure 4

An example of the worksheets (PT7FM)



RESULTS, DISCUSSIONS, AND SUGGESTIONS

Reflective thinking in problem-solving is needed in uncertain and problematic situations (Kitchener & Fischer, 1990). This research was conducted to determine the reflective thinking skills used in problem-solving and to model this process. The research results showed that reflective thinking emerges at all stages of problem-solving and affects the whole process. The research results are align with the results of the research conducted by Kholid et al. (2020). Kholid et al. (2020) also determined that pre-service mathematics teachers use all reflective thinking components in the problem-solving. The research results revealed that reflective thinking was used while understanding the problem, planning for the solution, choosing a strategy, applying the plan, and evaluating the solution. Therefore, it can be thought that reflective thinking is practical at every stage of problem-solving and makes it possible to be successful. Reflective thinking is a problem-solving approach that starts due to mental complexity, requiring identifying the problem and looking at this problem from different perspectives (Dewey, 1933; Kember et al., 2000; Öztürk, 2003). Other researchers also stated that it is essential for students to think reflectively in identifying and solving problems and adapting them to different situations (Dewey, 1933; Schön, 1983, 1987). Van de Walle et al. (2014) also emphasize the importance of students reflecting on their experiences in the problem-solving process. They state that students should have time to think and discuss their solutions. Reflection during the problem-solving process can increase students' awareness of their mental activities, including cognitive and metacognitive thinking, and enable them to approach their learning consciously. Thus, it can provide an opportunity for them to review and internalize not only the procedures and algorithms for the problem's solution but also the thinking methods and strategies.

Another point to be emphasized is that students should encounter non-routine problems to enable them to use their reflective thinking skills. Non-routine problems require individuals to reflect on problems using their existing knowledge, experiences, and beliefs (Kember et al., 2000). In schools, students often encounter routine problems with only one solution. However, as reflection skills develop, their ability to cope with non-routine problems will also improve (Schön, 1987). Therefore,

developing students' reflective thinking skills is necessary by including non-routine problems in mathematics lessons.

The role of the teacher in this process is also critical because it is very important to support and guide students in reflective thinking skills. The teacher can help students with written diaries, peer discussion, and evaluation (Lai & Land, 2009). They can also apply various strategies to encourage reflective thinking like asking open-ended questions, accepting contradictory comments, and writing down what children say (Epstein, 2003).

The model of reflective problem-solving confirmed its cyclical and dynamic nature. It has been revealed that the problem-solving process includes up and down transitions according to the success of solving the problem and the accuracy of the result. In other words, the student can return to the previous step between successive stages. While trying to determine a solution, he can reread it, thinking he does not understand the problem. However, the false result, especially in the evaluation phase, causes a return to the previous stages of problem-solving. When the false result emerges, the student thinks about where the error originates and returns to the stages of understanding the problem, planning, and implementing it to identify the error. Reflective thinking is applied more actively and mainly after this stage. The problem-solver reread the problem, questions whether he has understood it correctly, and addresses it differently. Returning to the planning stage, he reviews the strategy and considers whether there is a need for a new plan/strategy/solution. Then he checks the stage of carrying out the plan and examines whether there are errors. He tries to find the correct result. In this process, it was understood that reflective thinking facilitates reaching the correct result by giving direction to all stages. It is seen that the model developed for reflective thinking skills in the problem-solving process is compatible with the model developed by Yimer and Ellerton (2010) in terms of the fact that reflective thinking is effective in the whole problem-solving process.

Reflection, embedded in the whole problem-solving, can increase the students' problem-solving success and improve their mathematical competencies. Therefore, it should be ensured that students use reflective thinking more consciously in problem-solving activities in classroom practices. In this regard, it should be ensured that both pre-service primary teachers and primary teachers should be trained in reflective thinking in the problem-solving process.

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Developing Reading and Listening Skills of an Inclusion Student: An Action Research

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Abstract

Inclusion students, like all students, need to develop strong reading and listening skills to communicate effectively, understand instructions, and retain information. These skills are also important for their independence and future career success. Improving these skills can help inclusion students to achieve their academic, social, and professional goals. The main purpose of this research is to improve the reading and listening skills of an inclusion student studying at the 2nd grade level. For this purpose, the study was designed and conducted as an action research. First of all, the current level of the student in reading and listening skills was determined. Interactive reading and repeated reading methods were used in the intervention process. The intervention process of the study lasted for 6 weeks. In this process, 14 different children's picture books were read by the student's parents using the interactive reading method. Then, the student was allowed to read children's picture books until he reached the level of free reader. As a result of the research, it was concluded that the student made fewer reading errors than before the intervention process, the rate of word recognition and the reading prosody score increased, and the success of reading comprehension and listening comprehension improved.

Keywords

Reading and listening skills, children's picture book, interactive reading, inclusive student.

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INTRODUCTION

Basic language skills -listening, speaking, reading, and writing- are indispensable in academic and social life. Individuals can express themselves and explain their feelings and thoughts by using their language skills. At the same time, language skills are needed to understand the feelings and thoughts of others. Basic language skills consist of listening, speaking, reading, and writing. Reading and listening skills are necessary to understand Turkish and speaking and writing skills are necessary to be able to explain it (Çal & Erdoğan 2017). These skills are closely related to each other from the acquisition stage. Chermak and Muisek (1997) claim that the region of the brain used for the reading function is located within the region used for the listening function. Listening and reading skills are essential for understanding and acquiring knowledge. Reading is a process that requires more cognitive performance than listening skill (Emiroğlu & Pınar, 2013).

Reading is the process of constructing meaning, which is based on effective communication between the writer and the reader, takes place in line with a specific purpose and method, and uses prior knowledge. Reading is also expressed as an interactive comprehension process that takes place with a mental effort in which shapes are transformed into sounds (Coltheart, 2005). The reading process, which starts with vision and vocalization and continues with the brain performing various skills, is completed by going through the stages of seeing, understanding, and structuring in the mind (Akyol & Çoban-Sural, 2021). Voice, sound awareness, word recognition, fluent reading, and reading comprehension skills are required to reach a sufficient level of reading (NICHD, 2000; NRP, 2000). Reading and reading comprehension are related to each other in a cause-effect relationship. The main purpose of reading is to understand what is read (Güngör, 2005).

Reading comprehension can be defined as the process of constructing meaning in which the reader uses his/her prior knowledge and interacts with the text while reading it (Duke, 2003). Reading comprehension is a cognitive and social activity that is directly related to many academic activities (Paris, 1991). Word recognition is the reader's understanding of the word when s/he sees it, and it forms the basis of reading, reading comprehension, and fluent reading skills (Akyol, 2019; Yangın & Sidekli, 2006).

Fluent reading is carried out as if speaking, paying attention to punctuation, emphasis, and intonation, without word repetition and pauses (Allington, 2006). Tompkins (2006) and Hudson, Pullen, Lane and Torgesen (2008) point out that individuals who cannot read fluently will have difficulty understanding what they read.

It is known that reading, reading comprehension, fluent reading, and word recognition skills seriously affect students' academic success (Gallik, 1999). In addition to academic success, these skills help students with intellectual disabilities maintain their daily life activities, develop themselves in various fields, gain mental independence and develop their social skills (Akdağ, 2019; Güneş, 2007; MEB, 2004; Özak, 2008). It is thought that these skills have an important place in the primary school process and that the most effective people to manage this process are the classroom teachers. In the process of gaining these skills, teachers should model for their students instead of teaching them directly, and thus enable students to learn indirectly (Borich, 2013; 2014). Interactive and repeated reading is one of the important reading techniques that teachers can use within the indirect teaching model (Ceyhan, 2019). Duran and Öztürk (2018, p.88) argue that one of the basic steps of education is listening. Başkan and Deniz (2015, p.183) also state that individuals with improved listening skills will achieve success in their academic life, their quality of life increases, and they can better defend their rights. Listening skill

helps people to carry out a command and establish healthy communication. Listening skill has a complex structure and needs to be supported by comprehension activities (Gilakjani & Sabouri, 2016, p.129).

Reasons such as intellectual disabilities, language and speech disorders, and sensory and emotional issues that some students have cause problems in these students' learning or reading development (Seçkin Yılmaz & Baydık, 2017). There are some limitations and inadequacies between mental functions and social and practical adaptation skills in individuals with intellectual learning disabilities (Fidan & Akyol, 2011). Intellectual disabilities can be classified as mild, moderate, and severe, and individuals with mild intellectual disabilities experience delays in acquiring basic literacy and counting skills (Fidan & Akyol, 2011). Although delays are observed in the reading processes of individuals with intellectual disabilities, these individuals can also learn to read when sufficient resources are provided, and time and attention are given (National Joint Committee on Learning Disabilities [NJCLD], 1993).

When the national and international literature is examined, it is seen that there are many studies about students with special needs (Akoğlu & Turan, 2012; Alghazo & Naggar-Gaad, 2004; Avcıoğlu, 2012; Bakkaloğlu & Sucuoğlu 2000; Browden, Wakeman, Spooner, Ahlgrim-Delzell & Algozzinexya, 2006; Çatak & Tekinarslan, 2008; Diken & Sucuoğlu, 1999; Eliçin, Dağseven Emecen & Yıkmış, 2013; Eripek, 2004; Freeman & Alkin, 2000; Girgin & Baysal, 2005; Güldenoğlu & Kargın, 2012; Öztürk & Eratay, 2010; Şahbaz, 2006; Varol, 2009; Yıkmış, Tekinarslan & Sazak Pınar, 2006; Wright, 1999), reading difficulties (Akyol & Kodan, 2016; Akyol & Sever, 2019; Akyol & Sural, 2021; Baydık, 2011; Dinç, 2016; Dündar & Akyol, 2014; Meiri, Levinson & Horowitz-Kraus, 2019; Nation 2019; Özkara, 2010; Özmen, 2005; Seçkin, 2012; Sidekli, 2010; Türkmenoğlu & Baştuğ, 2017; Uysal-Kanık & Akyol, 2019; Yangın & Sidekli, 2006; Yüksel, 2010; Zijlstra & van Bergen, 2020), learning disability (Başar & Göncü, 2018; Baten & Desoete, 2019; Delimehmet-Dada & Ergül, 2020; Deniz & Aslan, 2020; Ergül, 2012; Fidan & Akyol, 2011; Hendricks & Fuchs, 2020; İlker & Melekoğlu, 2017; Shen & Troia, 2018; Yazdi-Ugav, Zach & Zeev, 2020) and interactive reading (Yıldız-Bıçakçı, Er & Aral, 2018; Çetinkaya, Ateş & Yıldırım, 2019; Er, 2016; Ergül, Sarıca & Akoğlu, 2016; İlhan & Canbulat, 2021; Karadoğan, 2020; Moss, 2016; Seyit, Akbay, Yıldırım & Çetinkaya, 2020; Sezer, Çetinkaya, Tosun & Yıldırım, 2021; Yıkmış, 1999; Yurtbakan, 2020; Wauters & Dirks, 2017; van der Wilt, Boerma, van Oers & van der Veen, 2019). Nevertheless, among these studies, there was no study about using the interactive reading method on a student with special needs. The research is also important in terms of presenting a reading method that can be used by teachers who have students with special needs in their classrooms and showing a method that will contribute to parents who have children with special needs. This research aimed to improve the reading and listening skills of a student with mild intellectual disability by using the interactive reading method.

METHOD

The Research Model

This research aimed to improve the reading and listening skills of a 2nd-grade inclusive student. In this study, action research, one of the qualitative research designs, was used. Action research is a practice-based type of research used when the researcher is personally involved in the problem (Patton, 2002). Action research is an approach to data collection and analysis, carried out by practitioners or the researcher himself/herself, to understand and solve an existing problem posed by the practice process (Yıldırım & Şimşek, 2005). Considering that the researcher is personally involved in the problem, it is

necessary to prefer action research, which is an approach that includes systematic data collection and analysis to understand and solve a problem that has already arisen.

Participant

The participant continues his education at the 2nd grade level as an inclusion student in a public school in a district of Kocaeli Province. The participant is 8 years old, male, and the only inclusive student in a class of 24 people. He has an older brother and a younger sister. His older brother is a 4th-grade student at the same school as the participant. Although there is no inclusion report, it is stated that he is a good reader according to the interview with his teacher. His other sibling did not reach school age. As a result of the interviews with the parents, it was learned that his academic studies were mostly completed with the help of his mother and mother at home. He does not have any physical special needs other than his mild intellectual disability. He could not participate in distance education, which started during the pandemic period, due to technological inadequacies. At the end of the first grade, his classroom teacher shared with the researchers that he had reading and comprehension skills appropriate for the first-grade level. However, he could not follow the lessons in the 2nd grade and was exposed to learning losses. His mother is a high school graduate, and she is a housewife. His father has an associate degree. It is known that his father worked in the private sector in the working class. In line with the income information obtained from the student information form, it can be said that the family is at a low socioeconomic level.

Data Collection Tools

Word Recognition

The word recognition percentage formula, stated by Akyol et al. (2014), was used in this study. According to this formula, the word recognition percentage is found by calculating the number of words read correctly / the total number of words read in a 60-second oral reading process.

Prosody

The Multidimensional Fluency Scale, which was developed by Zutell and Rasinski (1991) and adapted into Turkish by Yıldırım, Yıldız and Ateş (2009), was used to determine the prosody. The scale consists of 4 dimensions: expression and volume, phrasing, smoothness, and pace. The highest score that can be obtained from the scale is 16 and the lowest score is 4. According to Akyol et al. (2014), at the end of the year, if a student's score is 8 or below 8, it indicates that the student needs additional evaluations.

Reading Comprehension

The Error Analysis Inventory adapted by Akyol (2017) from Haris and Sipay (1990), Ekwall and Shanker (1988), and May (1986) was used to determine reading and reading comprehension. In the process of determining the level of reading and comprehension, the text titled "The First Dream", which was stated to be suitable for the second-grade level by Akyol and Sever (2018), and the comprehension questions for this text were used.

Listening Comprehension

The participant’s listening comprehension skill was measured using the sentence verification technique (SVT). The text titled “The Story of the Toys” prepared by Akyol et al. (2014) for the second-grade level and the questions prepared by Akyol et al. (2014) for this text were used. SVT can be used in texts composed of 12 sentences or rewritten text with 12 sentences. SVT questions are directed to

students by using the original sentence, expressing the original sentence with other words, changing the meaning of the original sentence, and creating distracting sentence formats. 80% or more of the correct answers from the SVT indicate a good understanding, between 71-79% a medium level of understanding, and correct answers below these rates indicate poor understanding (Royer, 2001).

Techniques Used in Research

Interactive Reading

Reading as a way of learning can be realized in a variety of purposes and ways. Visual reading, critical reading, guided reading, casual reading, and interactive reading are some of these reading types (Arıcı, 2012). Interactive reading is defined as a reading method in which the roles of the reader and the listener change, allowing them to criticize and discuss the text, and enabling the reader to participate actively in the reading process (Yıldız-Bıçakçı, Er and Aral, 2018; Snow and Ninio, 1986; Whitehurst et al., 1988). Çetinkaya, Öksüz and Öztürk (2018) stated that the interactive reading method will contribute to each component of reading separately. When the literature is examined, it is seen that interactive reading facilitates students' vocabulary learning (Brett, Rothlein & Hurley, 1996), and enables them to learn new words (Penno, Wilkinson & Moore, 2002; Smeets, van Dijken & Bus, 2014), improves their early literacy skills (Hargrave & Senechal, 2000) and contributes to their expressive language (Lever & Sénéchal, 2011). In addition, interactive reading is also effective for students with speech disorders, language disorders, hearing impairment, down syndrome, and autism (Yurtbakan, 2020).

Repeated Reading

Dündar and Akyol (2014) define repeated reading as a reading method based on re-reading a text until it is read fluently. When the reader reads the text fluently, s/he switches to another text and the process continues in this way (Samuels, 1997). This reading method is especially effective for students who read slowly, incompletely, and incorrectly. This method, which improves reading fluency and reading comprehension (May, 1986; O'Connor, White, & Swanson, 2007), can be applied both alone with the student and under the guidance of the teacher. In addition, repeated reading is a reading development strategy that can be used for weak readers and students with learning difficulties (Dündar & Akyol, 2014; Rashotte & Torgesen, 1985; Reutzel & Cooter, 1996; Yılmaz, 2006).

Research Process

Determining Reading and Reading Comprehension Level

To determine the current reading level of the participant, the text titled "The First Dream", which was stated to be suitable for the second-grade level by Akyol and Sever (2018) was used. The text consists of 92 words. The participant was asked to read the text aloud. Video recording was taken during the reading. The participant's reading mistakes were determined by watching the video again. Before the practice, it was seen that the participant's reading and reading comprehension skills were not at the desired level.

Determining the Listening Comprehension Level

The participant's listening comprehension skill was measured using the SVT method. Text and SVT questions prepared in accordance with the second-grade level by Akyol et al. (2014) were used. The text was voiced to the student by the researcher and then the questions were directed. Thus, the

participant's listening comprehension scores were revealed. It was found that the participant's listening comprehension scores before the implementation were not at the desired level.

Developing an Action Plan and Data Collection

As a result of the preliminary evaluations, it was seen that the participant needed support in reading fluency and reading and listening comprehension skills. Since the participant could not get educational support at school due to the pandemic process and could not participate in distance education due to technological inadequacies, it was focused on what the parents could do at home. By examining the relevant literature, it was thought that reading fluency, reading comprehension, and listening skills could be improved by making interactive reading with the participant. The participant's family was contacted and asked if they could do an interactive reading at home. His father stated that he could voluntarily carry out interactive reading studies. The sample interactive reading process was introduced to the participant's father via Zoom. During the interviews with the student's classroom teacher and parents, it was learned which types of books could be of interest to the student. Then, the books to be used in the interactive reading process were determined in line with the expert opinions. During the process, parents were frequently informed about the interactive reading process. Information was exchanged about what happened in the process, and feedback was provided on the interactive reading process. The list of books used in the process is as follows:

Table 1

Books used in the interactive reading process

	The Title of the book	Publisher	Author
1	Madeline Finn and the Library Dog	Hep Kitap	Lisa Papp
2	Daddy's Sandwich	Beyaz Balina Publishing	Pip Jones ve Laura Hughes
3	Ernest	Türkiye İş Bankası Publications	Catherine Rayner
4	Sick Day for Amos Mcgee	Yapı Kredi Publications	Philip C. Stead
5	Laika Astronaut Dog	Meav Publishing	Owen Davey
6	Pezzettino	Elma Publishing House	Leo Lionni
7	The Giving Tree	Bulut Publications	Shel Silverstein
8	Kırmızı Elma	Yapı Kredi Publications	Feridun Oral
9	Stick and Stone	Beyaz Balina Publications	Beth Ferry
10	My Dad at the Zoo	Uçanbalık Publishing	Coralie Saudo
11	My Dad is Big and Strong But…	Uçanbalık Publishing	Coralie Saudo ve Kris Di Giacomo
12	Annemin Çantası	Yapı Kredi Publications	Sara Şahinkanat
13	Lucy Lady Bird	İş Bankası Kültür Publications	Sharon King-Chai ve Sharon King-Chai
14	Kırmızı Kanatlı Baykuş	Yapı Kredi Publications	Feridun Oral

The interactive reading process is designed to read each book to the participant interactively with the parent every three days. The books were determined by taking information from the classroom

teacher and the parents and according to the expert opinions and the student's reading interests. Some of the selected books are father-themed is to make the interactive readings entertaining for the participant and his father. The other books were chosen from the books with animal characters, considering that the participant liked the books with animals more. The book, which was read interactively on the first day, was requested the participant to read it silently and repeatedly the next day, and repeated readings were made on the third day. It is aimed to increase the student's word recognition rate with repeated readings. Children's picture books to be read in the process were provided and delivered to the participant, and the intervention process of the research started. The family was kept in touch throughout the implementation process. The intervention process, which included interactive readings and repeated readings of the student's book, was completed in 6 weeks.

Validity and Reliability

To ensure the reliability of the research data, the data obtained during the research process were scored by two different experts. In the scoring process, the reliability formula of Miles and Huberman (1994) was used. According to this formula, the consensus among the encoders is calculated with the formula (Consensus/Term number) x 100. In the process of measuring reading and listening skills, field experts did not dissent. In this context, the ratio obtained from the reliability formula can be expressed as 100%.

The three experts' opinions on classroom education were used in the selection of the books to be used in the research process. In line with expert opinions, books suitable for the research's purpose were determined and included in the process. Since the interactive readings will be carried out by the parents during the research process, sample interactive reading practices were carried out with the parents at different times before starting the implementation process. These implementations took 80 minutes. Thus, it is aimed that the parents have theoretical and practical knowledge about interactive reading.

Ethical Principles

Ethics committee permission for this study was obtained from Düzce University Scientific Research and Publication Ethics Committee with the decision dated 24.06.2021 and numbered 10/2021-176.

FINDINGS

In line with the data of the research, findings on reading fluency, reading comprehension skills, and listening comprehension skills were obtained. Below are the findings regarding the number of reading errors and types of errors before and after the implementation. The number of errors and the type of error made by the participant are as follows.

Table 2

Number of errors by participant's error type before implementation

Error type	f
Skipping	25
Adding	2
Misreading	14
Repetitions	4

Read Backwards	-
Total	45

It is seen that the participant made 45 reading errors while reading a 92-word text. The majority of reading errors consist of skipping and misreading. According to Ekwall and Shanker's (1998; cited in Akyol, 2014) table of "Misread words", the participant is at frustration reading level.

The participant read 56 words during the 60-second oral reading period. During this reading process, he made 15 errors. He read 41 words correctly. In this context, it is seen that the participant's word recognition rate is 73%. Akyol et al. (2014) point out that the word recognition rate for the instructional level is between 92% and 98%. The fact that the participant's word recognition rate was 73% indicates that he needs support in terms of word recognition.

The participant's prosody was determined by the Multidimensional Fluency Scale, which was developed by Zutell and Rasinski (1991) and adapted into Turkish by Yıldırım, Yıldız and Ateş (2009). The points of the participant from the rubric are as follows:

Table 3

Prosody scores before implementation

Prosody	Point
Expression and Volume	2
Phrasing	1
Smoothness	1
Pace	3
Total	7

When the participant's prosody is examined, it is seen that he got 7 points from the rubric. According to Akyol et al. (2014), scores of 8 and below from the rubric indicate that support is needed for prosodic reading. If the current reading level of the participant is summarized, it turns out that he made too many reading errors and could not read fluently.

Comprehension questions developed by Akyol and Sever (2018) were used for the text of "The First Dream" to determine the participant's reading comprehension level. These questions consist of 5 questions, 4 of which are simple level understanding and 1 deep understanding question. The highest score that can be obtained from the questions is 11. The participant could not answer any of the questions correctly. The participant's comprehension score was 0/11. With this result, it is seen that there are significant deficiencies in the participant's reading comprehension skills.

Listening Comprehension

The listening comprehension skill of the participant was measured using the SVT method. As a result of this process, it was determined that three of the 12 questions were correctly remembered by the participant. This result indicates that the listening comprehension score is only 25%. However, according to Royer (2001), SVT scores of 70% or less indicate that there are problems in comprehension.

Table 4

Numbers of errors and error types before the implementation

Error type	f
Skipping	-
Adding	2
Misreading	5
Repetitions	8
Read Backwards	-
Total	15

After the implementation process, the text that was read to the participant before the implementation was read aloud again. The reading process was video-recorded and watched repeatedly, and reading errors were revealed. When Table 4 is examined, it is seen that 15 reading errors were made in the 92-word text. This shows that the participant is still at frustration reading level. However, the participant who had 45 reading errors before the implementation reduced this number to 15. The participant's errors decreased. Skipping, which was the most frequently recurring error type before the implementation, was not encountered after the implementation. It can also be thought that the participant corrected his reading errors since his books were written in different styles and with different fonts. After the implementation, the participant read 47 words in a 60-second oral reading period. During the 60-second reading aloud, the participant made 7 reading errors. The participant's word recognition rate after the implementation was 85%. It is seen that the participant has not yet reached the educational level. When the word recognition rate is compared before and after the implementation, it can be stated that the word recognition rate is 13% higher after the implementation. The total number of words read by the participant during the 60-second oral reading period decreased from 56 to 47. However, the correct reading rate has increased. The decrease in participant's reading speed may be a result of paying more attention to the prosody and word recognition dimensions of fluent reading. The participant's prosody scores before the implementation are as follows.

Table 5

Prosody scores after the implementation

Prosody	Point
Skipping	3
Adding	2
Misreading	2
Repetitions	2
Total	9

The participant got 9 points from the prosody rubric after the implementation. It is known that the participant's prosody score before the implementation was 7. According to Akyol et al. (2014), if the scores obtained from the prosody rubric are 8 and below, it is indicated that the participant needs

additional teaching support. With the interactive reading implementation, the participant's prosody score increased from 7 to 9. Thus, the participant achieved a prosody score higher than 8 points.

The participant's reading comprehension scores after the implementation were re-measured using the text and comprehension questions used before the implementation. Before the implementation, the participant's reading comprehension score was 0/11. After the implementation, the participant gave a correct answer to 1 of the 5 questions and a partially correct answer to 2 of them. The participant's reading comprehension score after the implementation is 4/11. The participant's reading comprehension level is still at frustration reading level, but giving a completely correct answer to 1 question and partially correct answer to 2 questions allows it to be interpreted that his reading comprehension skill is positively affected.

Listening Comprehension

When the participant's listening comprehension scores before and after the implementation were examined, it was revealed that he answered three of the 12 questions correctly before the implementation, and this number increased to 8 correct answers out of 12 questions after the implementation. It is seen that the participant's listening comprehension correct answer rates are 25% before the implementation and 66% after the implementation. According to Royer (2001), the correct response rate for listening comprehension, which increased to 66% after the implementation, is insufficient. Royer (2001) argues that this rate indicates the frustration reading level when it is 70% or less. Although the participant did not get the score to reach the instructional level, it can be stated that his listening comprehension skill increased considerably after the implementation.

RESULTS, DISCUSSIONS, AND SUGGESTIONS

In the results of this research, which aims to improve the reading and listening skills of an inclusion student by using interactive reading and repeated reading methods, it has been concluded that the participant's reading and listening skills have improved. According to the results of the research, the participant's reading errors decreased, word recognition rate, prosody score, reading and listening comprehension scores improved.

The results of the research reveal that interactive reading increases the student's word recognition rate. Lewis and Doorlag (1983) and Yılmaz (2008) consider reading in two dimensions as word recognition and comprehension, and they mention that acquiring word recognition skills is a more difficult process for students with learning disabilities. Since word recognition is considered an important basis for reading comprehension, it can be said that individuals who are defined as good readers can recognize words quickly. (Fidan & Akyol, 2011; Yılmaz, 2008). Stahl (2003) states that the interactive reading method directly affects students' word recognition abilities. Similarly, in the studies conducted by Çetinkaya, Öksüz and Öztürk (2018), Durmaz (2020), Mol, Bus, de Jong and Smeets (2008), Levin and Aram (2012), Gölcük, Okur and Berument, (2015), Whitehurst et al., (1994), Wiseman (2011), Karatay (2007), Sever (2011), Hargrave and Senechal (2000), it was concluded that the interactive reading method affected the students' vocabulary. Since it is known that the increase in the vocabulary will also affect students' word recognition skills (Çetinkaya, Öksüz, & Öztürk, 2018), these studies support the findings of this study. Vocabulary is among the general objectives of the Turkish course, and it is emphasized that it should be expanded (MEB, 2019). Karadoğan (2020) emphasizes that while reading studies are carried out, it is necessary to address the individual's

vocabulary. Vocabulary is an important element that affects reading and reading comprehension (Biemiller, 2003). Therefore, expanding students' vocabulary will significantly affect their academic lives.

Within the research, it was concluded that interactive reading had a positive effect on the student's reading comprehension skills. In the study of Ergül, Akoğlu, Karaman and Sarıca (2017), the interactive reading practice was applied to 72 students in the preschool period. When these 72 students started 1st grade, they were included in a study with their peers who were not included in the interactive reading process. It was concluded that there was a significant difference between the students who were included in the interactive reading implementation in the preschool period and the students who were not included in terms of the number of correct words they read per minute, the reading time, the number of meaningless words read correctly and their reading comprehension. When the literature is examined, it has been revealed in the studies conducted by Akoğlu, Ergül and Duman (2014), Er, (2016), Karadoğan (2020), Whitehurst & et al. (1988), Beyreli and Amanvermez İncirkuş (2018) and Ergül et al. (2016) that the interactive reading method affects the reading comprehension skills of the students. In addition, Özbay and Melanlıoğlu (2008), Çeçen (2007) and Sever (2011) also emphasize that the interactive reading method contributes to the vocabulary and thus the intelligibility of the reading material will increase. These studies coincide with the data of this study.

In Yurtbakan's (2022) study, interactive reading done by parents and teachers together and interactive reading made by only the teacher were compared. Children who perform an interactive reading with their parents have higher reading fluency and reading comprehension skills. Beschorner and Hutchison (2014), Gladwin and Stepp-Greany (2008) and Ceyhan (2019) state that the interactive reading process carried out by parents improves students' reading comprehension skills. It can be said that the participation of the parents in the interactive reading process improves the student's reading motivation, and this situation is effective in the development of the participant's reading skills. Reading motivation plays an important role in the development of fluent reading (Schwanenflugel et al., 2009). Since it is known that the reading motivation and reading attitudes of the students participating in interactive reading practices with their parents increase (Loera, Rueda, & Nakatamo, 2011; Kotaman, 2013), it can be argued that the participation of the parents in the process also contributed to the development of the participant's reading skills.

Reading errors are one of the main problems affecting fluent reading and reading comprehension skills (Akyol & Temur, 2008; Dündar & Akyol, 2014). The main word errors revealed in the studies carried out by Sarıpınar and Erden (2010), Sidekli (2010), and Bay (2010) are reading by skipping letters, syllables and words, adding letters, syllables, words, repetition of lines, words and sentences, pronunciation problems, mixing the letters of the word, following the words with fingers and not being able to read the word at all. In the study of Sarıpınar and Erden (2010) titled "Usability of Tests Measuring Academic Skills and Sensory-Motor Functions in Reading Disability", the statistical relationship between reading errors and various variables was examined. In the study, it was concluded that there was a significant difference between class level, socioeconomic level, gender, and reading errors. In addition, reading errors made by students with and without reading difficulties were examined and it was determined that students with reading difficulties were more prone to making mistakes. In the studies of Efe and Temel (2018) and Ergül, Akoğlu, Sarıca, Turan and Karaman (2005), it was concluded that the interactive reading method affects students' reading skills in various ways. Dundar and Akyol (2014), on the other hand, used the repeated reading method in a study they conducted with a second-grade student with reading and comprehension problems to ensure the

reading motivation of the student and thus eliminate reading errors. In this study, it was seen that the student's reading errors decreased thanks to repeated reading and interactive reading.

Prosody can be defined as paying attention to tone, emphasis, and intonation while reading a text (Rasinski, 2004). Prosodic reading can also be explained as reading as if speaking. Prosodic reading, which is seen as a basic element for the realization of fluent reading, is an important concept that helps the readers to understand what they read and for the listeners to understand what they are listening to (Hudson, Lane, & Pullen, 2005; Pikulski & Chard, 2005). Caldwell (2008), Ergül (2012), and Furnes & Samuelsson (2009) state that students with reading difficulties have problems with prosodic reading skills. Eliminating this problem is necessary for academic success, as students will have difficulty understanding what they read when they cannot read prosodic. In this study, the positive effects of interactive reading and repeated reading methods on the reading prosody scores of a student with an intellectual disability are seen. In the research of Ayar (2007), Mitchell (2009) and LaRocco (2008), it was concluded that the repeated reading and, in the research, carried out by Ceyhan (2019), the interactive reading affected fluent reading skills of the students. Based on these studies, it can be concluded that repeated and interactive reading affects students' prosodic reading skills.

Within the research, various recommendations were given to both teachers and researchers. These are:

1. More interactive and repeated reading studies can be done on different variables with students with reading difficulties, learning difficulties, inclusion reports, and intellectual disabilities.

2. In the research, two reading methods were used, namely repeated reading and interactive reading. These methods can be diversified, and studies can be carried out with students who have an inclusion report.

3. Teachers can do interactive reading activities in their classes with students who have inclusion reports.

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Psychometric Properties of Basic Needs Scale Based on Choice Theory (BNSBCT)

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Abstract

Choice Theory, which is a well-established psychological framework that emphasizes the importance of meeting basic psychological needs for human well-being and optimal functioning. The use of a reliable and valid measure like the BNSBCT can lead to more accurate and meaningful research findings, which can inform the development of interventions or policies aimed at improving individuals' basic psychological needs fulfillment in various contexts especially in education. The aim of this study was to develop a measurement instrument to find out the satisfaction levels of basic needs in adult population and to test the psychometric properties of the scale. Individuals aged 18 and older, who were reached with convenience sampling method, participated in the study. Exploratory Factor Analysis was conducted with the data obtained from 381 participants, while Confirmatory Factor Analysis was conducted with the data obtained from 194 participants and goodness of fit indices were found to be χ^2/df= 1.64; GFI=.85; IFI=.91; TLI=.90; CFI=.91; PNFI=.71; PGFI=.69; SRMR=.64 and RMSEA=.06. The 25-item scale includes five factors. Face validity of the scale is .91, while convergent validity value is .70. In terms of reliability, McDonald's Omega coefficient was found to be .92, while test-retest correlation coefficient was found to be .83. The results show that Basic Needs Scale based on Choice Theory is a valid and reliable measurement instrument. As a result, it can be stated that the scale can be used to determine the level of meeting the basic needs of adults.

Keywords

Choice theory, Basic needs, Validity, Reliability.

Ethics Committee Approval: Ethics committee permission for this study was obtained from Sakarya University Ethics Committee with the decision dated 11.05.2022 and numbered 45/08.

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INTRODUCTION

William Glasser is the founder of Choice Theory (Wubbolding, 2017). In Choice Theory, Glasser argues that individuals have the power to choose over their thoughts, feelings and behaviors (Glasser, 1998). This approach emphasizes that individuals are free and responsible for their choices (Jusoh, 2018). Choice Theory is the conceptualization of human behavior that promotes the focus of internal control. According to this theory, all we do from birth to death is the attempt to match our needs with the images in our world of quality to meet one or more of our needs (Patkar, 2018).

Even if behaviors are influenced by factors outside the individual, the power that drives them is within the individual. Individuals choose their form of behavior, and the purpose of this choice is to meet their needs at that moment (Corey, 2015). In short, according to Choice Theory, all behaviors are intentional. They are motivated by a desire to satisfy one or more of our basic needs, especially in relationships with others and/or ourselves (Glasser, 1998). It can be stated that individuals' behaviors are triggered by needs.

Choice Theory is based on the principle that all motivation for human behavior stems from innate needs and more specifically from individuals' wishes (Glasser, 1998). Human needs and wants give energy to behavioral system to influence the world in a personally and internally satisfying way (Wubbolding, 2017). Choice Theory explains in detail that all happiness and suffering result from the effort to satisfy the five basic needs inherent in individuals' genes –survival, freedom, fun, power, love and belonging (Glasser, 1998). The need to love and belong refers to individuals' building satisfying relationships with family members, friends, neighbors, individual/s they have romantic relationships with, spouses and children (Glasser, 2003). The genetic program of all living beings is encoded on the need to survive. Another aspect of this need is the desire for the survival of species (Glasser, 1999). Depending on the need to survive, some of the superior living beings want love. Many living beings seek for freedom. Most play games when they are young and it can be seen that they have fun in these games. On the other hand, the need for power is different from other needs. This need is specific to humans. The power humans seek is a need only seen in their kind (Glasser, 2003). Glasser (1999) states that fun is a feature in the genetic structure of sophisticated living beings. There may be many things to do for fun and only laughing can contribute to meeting this need; however, problems in relationships have a negative effect on having fun. As stated by Glasser (1998), "freedom concerns us mainly when we perceive it to be threatened". When individuals perceive themselves under threat, their first concern is to lose their freedom. The more individuals have the freedom to satisfy their needs in a way that does not conflict with the needs of others, the more they can use their creativity (Glasser, 2003). Any behavior that tries to meet one or more of these needs but fails is painful. Mental health problems occur when any of these are not met (Wubbolding, et al, 2004).

According to Wubbolding and Brickell (1999), the most basic source of human motivation is the internal system of human needs. Since the system is internal, it can be controlled neither by external forces nor by past experiences. In this context, it can be said that individuals' needs and accordingly their behaviors are under their own responsibility. Needs, along with individual and specific wants, serve as motivators or sources of all human behavior (Wubbolding et al., 2004). Considering the effects of needs on individuals' behaviors, it can be said that determining the level of five basic needs revealed in the approach will provide important data to understand the behavior of individuals.

Purpose of the Present Study

Testing the basic needs put forward in Choice Theory has attracted many researchers (Türkdoğan & Duru, 2012). It can be said that measurement instruments for different age groups have been developed in various cultures to determine basic needs and the level of meeting these needs. In this context, it can be seen that Basic Needs Survey (Harvey and Retter 1995), Students Need Survey (Burns et al., 2006) and Scale of Filipino Students Need (Elnar, 2015) have been developed for children and adolescents; The Contextual Needs Assessment (Brown and Swenson, 2005) has been developed for university students and Choice Theory Basic Needs Scale (LaFond, 2000) and Basic Needs Inventory (Huffstetler et al., 2004) have been developed for adults. In Turkish culture, based on the Choice Theory, İkinci (2003) has developed Basic Needs Scale for adolescents, Türkdoğan and Duru (2012) have developed Basic Needs Scale for University Students and Eşici (2021) has developed Basic Psychological Needs Scale for individuals in emerging adulthood. On the other hand, no measurement tool has been found measuring the level of meeting basic needs in adults in Turkish culture.

The level of meeting basic needs can affect individuals' physiological and social health. Covid-19 pandemic that started as of February 2020 caused the death of 6.266.324 people worldwide (World Health Organization, 2022). Due to Covid-19 pandemic that affected the whole world, problems occurred in meeting the basic needs (Matias, Dominski, & Marks, 2020; Su, Rao, Li, Caron, D'Arcy, & Meng, 2022; Traoré, Combary, & Zina, 2022). Satisfaction of basic needs, even during extraordinary conditions such as pandemics and epidemics, can guide individuals' behaviors. For this reason, determining to what extent the basic needs of adults are met can be a guide in finding solutions to possible problems that may occur. According to the Ecological System Approach, the individual is at the centre of many systems that surround him/her. These systems are microsystem, mesosystem, exosystem and macrosystem from the closest to the individual to the furthest (Bronfenbrenner, 1979; 2001). These systems are in mutual interaction, and they have the potential to affect the individual positively or negatively (Bronfenbrenner, 1979). Microsystem and exosystem are important for student development. Microsystem includes parents, teachers, school administrators and school personnel, while exosystem includes neighbors, relatives, and friends of the parent (Bronfenbrenner, 1976). These are adults who can influence the development of children and adolescents. Therefore, determining the level of meeting the basic needs of adults and further research on this subject may allow obtaining scientific findings to support the development of students. In this context, the aim of the study is to develop a Basic Needs Scale based on Choice Theory, specific to Turkish culture and for adults, and to test the validity and reliability of the scale.

METHOD

Participants

The participants were selected via convenience sampling method. A total of 575 (383 female, 192 male) individuals between the ages of 18 and 65 ($\bar{X}$=31.14; *SD*=9.81) participated in the study which was conducted to test the psychometric characteristics of BNSBCT. It was found that 19.2% of the participants had postgraduate degree, 53.6% had bachelor's degree, 13.6% were high school graduates, and 7.1% were middle school or primary school graduates. 40.6% were single and 59.4% were married.

Within the scope of the study, the scale was applied to 381 (253 female, 128 male, $\overline{X}_{age}$=32,18 SD_{age}=9.97) participants between the ages of 18 and 65 and EFA was performed on these data. The scale was later applied to 194 (130 female, 64 male, $\overline{X}_{age}$=30.78, SD_{age}=8.43) individuals between the ages of 18 and 64 and CFA was performed on these data.

Data Collection Process and Ethical Considerations

The study was conducted with the 45/08 numbered permission as specified in the 12.05.2022 dated and 130478 numbered letter of the Ethics Committee of Sakarya University. Participation was provided on a voluntary basis. The data were collected online via Google Forms. Before applying the scale, the researchers asked the individuals whether they approved to participate in the study and data collection process was continued with those who ticked the "Yes" option. An informed consent form was also presented to the participants.

Instruments

Basic Needs Scale based on Choice Theory (BNSBCT)

A literature review was first conducted to develop BNSBCT. A temporary item pool was created based on the literature review. A team of experts in the field, two professors and two assistant professors in the field of psychology and the field of guidance and psychological counselling evaluated the items in the pool. Fleiss Kappa value was calculated to determine the consistency between the experts' evaluations of the items in the item pool and it was found to be .90. In addition, the views and suggestions of three language experts, one of whom had a master's degree in Turkish Language Teaching and two of whom had a master's degree in Turkish Language and Literature, were received. The pilot form prepared in line with the opinions of experts was applied to 36 adults (21 females, 15 males; $Range_{age}$=18-54, $\overline{X}_{age}$=28.57, SD_{age}=10.23). With the feedback from these individuals, the parts which were difficult to understand were revised and a 42-item trial application form was created. The form has 9 items for need for survival and 9 items for need for love and belonging, 8 items for need for power, 8 items for need for freedom and 8 items for need for fun. It is stated that making units smaller in a measurement process increases sensitivity and this increases the reliability of the measurement tool (Şekercioğlu, 2019). It was also determined that the 7-point rating offers a closer assessment to reality for the property to be measured (Finstad, 2010). Accordingly, 7-point Likert-type answering strategy was preferred instead of 3 or 5 points in order for the BNSBCT to make more sensitive and truthful measurements. During the process of developing a measurement instrument, the researcher should determine whether suitable sample size has been reached, which is a maximum of 250-300 individuals in factor analysis (Heppner, Wampold, & Kivlighan, 2008). While Tinsley and Tinsley (1987) suggested that the number of participants should be 10 times the number of items in the scale, Gorsuch (1990) stated that the number of individuals in the sample should not be fewer than the number of variables in the scale, in other words, the number of items. In line with this information, the measurement instrument prepared was transferred to "Google Forms" and applied online to 381 adults aged 18 and older. BNSBCT was applied to more than 9 times of the number of items in the scale for EFA.

University Students Basic Needs Scale – Short Form (USBNS-SF)

USBNS is a 7-Likert type measurement instrument developed for university students. The scale aims to determine to what extent the needs to be free, to love and belong, to have power, to have fun and to survive are met (Türkdoğan & Duru, 2012). The 19-item short form of the scale was created in 2020

by the researchers who developed the original form. 1150 students attending a university in the Western Anatolia region during the fall semester of 2016-2017 academic year participated in the development process of the short form. As a result of the EFA performed with the data obtained from the participants, it was determined that the scale had a five-factor structure and explained 67.40% of the total variance. Goodness of fit values of the 5-factor structure were examined with CFA. CFA results were as: χ^2/df=3.36, RMSEA=.045, CFI=.96, GFI=.96, AGFI=.94, SRMR=.034. Internal consistency reliability of the factors in USBNS-SF was calculated with Cronbach Alpha coefficient. In this context, it was found that Cronbach Alpha values were *.83 for need for freedom factor, .90 for love and belonging, .81 for power, .80 for fun and .81 for need for survival*. Higher scores from the scale indicate that the needs are met without problems and students have high need satisfaction (Türkdoğan & Duru, 2020). In Turkey, there is no measurement instrument that can determine the basic need level based on Choice Theory for adults. University Students Basic Needs Scale – Short Form was used in the present study to test criterion validity since it measures the five needs specified in the Choice Theory and since the present study included university students.

FINDINGS

Face validity

The aim of face validity is to evaluate the clarity and comprehensibility of the items in the measurement instrument. It is a type of validity which is calculated based on the views of individuals in the target group (Holden, 2010; Nevo, 1985) and it is calculated by taking the views of at least 10 participants (Yusoff, 2019). In this study, the scale was applied to 36 individuals to find out the face validity of BNSBCT and the individuals were asked to evaluate the clarity and comprehensibility of the items in the instrument between 1 (Not clear and comprehensible at all) and 4 (Totally clear and comprehensible). Scale-Face Validity Index/Average (S-FVI/Ave) value of the scale was found to be .91. The values obtained show that the scales have a sufficient level of face validity (Polit, Beck & Owen; 2007).

Exploratory Factor Analysis

Kurtosis and Skewness coefficients were calculated to find out whether the data obtained from applying BNSBCT to 381 individuals were normally distributed. Büyüköztürk (2002) stated that the value of the solution will decrease when normality is not met in Likert scales. He also stated that even if all linear combinations of the variables cannot be tested, normality of single variables can be evaluated with Skewness and Kurtosis coefficients. In this study, it was found that the Kurtosis and Skewness values of some items of the scale were not within the range of +1.5 and -1.5 suggested by Tabachnick and Fidell (2013). Mahalanobis values were calculated in order not to include outliers in the analysis (Karaman, 2015) and outliers were excluded. After excluding the outliers, it was found that the calculated Skewness coefficient of the remaining 369 data was -.64, (se=.13), while the Kurtosis coefficient was .39, (se=.25). Therefore, it was evaluated that the data met the assumptions of normal distribution (Tabachnick & Fidell, 2013), and EFA was started. Before EFA, Bartlett Sphericity test results were examined to find out whether the data set was suitable for analysis. In addition, in order to determine the adequacy of the number of individuals in the sample, Kaiser-Meyer-Olkin (KMO) index (Dziuban & Shirkey, 1974) was calculated and examined. The analyses conducted showed that the Bartlett Sphericity Test result (Approx. Chi-Square=4262.34; df=300) was significant ($p < .05$) and the KMO value was .92. These results show that the data come from multiple distribution and the

sample size is sufficient for EFA (Field, 2009). Suitability of the data for factor analysis can also be determined by calculating the correlation between the items (Tabachnick & Fidell, 2013). Can (2018) stated that factor analysis can be performed when the correlation coefficients between the items are .33 and above. In this context, the correlation between the scale items was calculated and EFA was started in line with the results obtained. EFA was conducted in line with these results. According to Büyüköztürk (2021), initially it is considered that there are as many factors as the number of items in the measurement instrument. For example, the trial form of BNSBCT has 42 items and therefore, it can be said that there were 42 factors initially. The aim of factor analysis is to reveal fewer factors that represent items with high correlation. There are different criteria about the number of factors (Karagöz, 2016; Tavşancıl, 2002). In this study, Principal Axis Factors (Costello & Osborne, 2005; Şencan & Fidan, 2020) method, which is widely used because it is not based on multivariate normality assumption and which is strong enough in factor extraction, was preferred. The explained variance values that emerged as a result of the analysis are presented in Table 1.

Table 1

BNSBCT Total Variance Values Explained

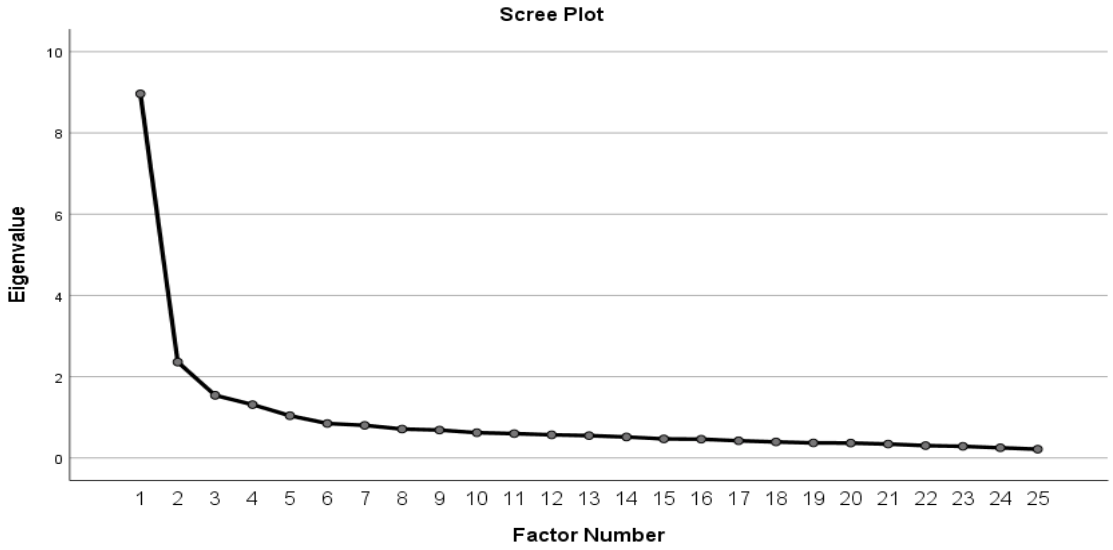
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.964	35.855	35.855	8.491	33.962	33.962	7.026
2	2.360	9.440	45.295	1.915	7.658	41.620	5.778
3	1.541	6.166	51.461	1.065	4.261	45.882	3.647
4	1.312	5.247	56.708	.837	3.349	49.230	6.577
5	1.039	4.157	60.865	.532	2.128	51.359	6.014
6	.849	3.394	64.259				
7	.803	3.211	67.470				
8	.710	2.841	70.312				
9	.687	2.747	73.058				
10	.621	2.486	75.544				
11	.598	2.394	77.938				
12	.569	2.275	80.213				
13	.549	2.195	82.407				
14	.516	2.065	84.472				
15	.469	1.876	86.348				
16	.462	1.846	88.194				
17	.423	1.694	89.888				
18	.394	1.578	91.466				
19	.370	1.481	92.947				
20	.366	1.464	94.411				
21	.342	1.368	95.779				
22	.304	1.216	96.995				
23	.286	1.144	98.139				
24	.250	.999	99.138				
25	.216	.862	100.000				

The first of the methods used in deciding the number of factors in the measurement tool is to take into consideration the factors with an eigenvalue of at least 1 (Özdamar, 2002; Thompson, 2008). When Table 1 is examined, it can be seen that there are five factors in BNSBCT with an eigenvalue above 1. It can be said that this 5-factor structure designated to measure the five basic needs is suitable for the theoretical basis of BNSBCT. Total variance explained by the five factors is 60.64.

The factor structure of BNSBCT that emerged as a result of EFA can be seen more clearly in the scree plot. While interpreting the plot, the factors up to the point where the vertical line becomes horizontal are included in the solution (Karagöz, 2016). Scree plot of the scale is shown in Figure 1.

Figure 1

Scree Plot of BNSBCT



When Figure 1 is examined, it can be said that the vertical line becomes horizontal after five factors. When the scree plot, rotated component matrix and total variance explained in EFA were examined, it was found that 25 items of BNSBCT were gathered under five factors. The correlations between the Pearson product-moment correlation coefficient and the five factors of BNSBCT were calculated and the results are presented in Table 2.

Table 2

Correlations between the factors of BNSBCT

Factors	1	2	3	4	5
Power					
Fun	.56**				
Survival	.35**	.33**			
Love & Belonging	.59**	.55**	.40**		
Freedom	.56**	.50**	.36**	.57**	

N=369, **p< .01

As can be seen in Table 2, there is a positive and significant (p<.01) correlation between the factors of BNSBCT. While there is a moderate level of correlation between love and belonging and power, there is a poor correlation between survival and fun. Tabachnick and Fidell (2013) state that rotation is required to interpret the factors. The authors also suggest that oblique rotation method should be preferred in cases where the correlation values between factors are 0.32 and above. As can be seen in Table 2, there is a correlation higher than 0.32 between the subscales of BNSBCT. Büyüköztürk (2002) recommends "Promax", one of the oblique techniques, because it is more applicable in the future compared to other techniques. For this reason, “Promax” was used in factor rotation. Tabachnick and Fidell (2013) advocate that the factor load of an item should be higher that 0.32. On the other hand, Stevens (2002) states that when the same item has loads in more than one factor, the loading difference between the two factors should not exceed 0.1. Another point that should be considered here is that a stable factor should not contain less than three items (MacCallum et al.,1999). In the EFA of BNSBCT, factor load of an item was found to be 0.40. The calculated Pattern Matrix results are shown in Table 3.

Table 3

Pattern Matrix of BNSBCT

	Subscales				
Items	Power	Fun	Survival	Love & Belonging	Power
I39	.887				
I41	.788				
I30	.736				
I26	.656				
I28	.597				
I35	.565				
I8	.538				
I32		.849			
I12		.746			
I42		.656			
I40		.645			
I23		.521			
I18		.401			
I9			.832		
I3			.787		
I17			.687		
I7			.519		
I24				.871	
I14				.707	
I33				.634	
I27				.620	
I21				.531	
I16					.777
I1					.728
I22					.467

When Table 3 is examined, it can be said that BNSBCT includes 25 items and five factors. As can be seen in the Table, need for “power” consists of seven items, “fun” consists of six items, “survival” consists of four items, “love and belonging” consists of five items and “freedom” consists of three items.

Confirmatory Factor Analysis

It was decided to conduct CFA to evaluate the EFA results of the scale and the 25-item scale was applied to 194 individuals. Before moving on to CFA, Skewness and Kurtosis values of the data obtained were examined. Since it was found that the specified values were not in the range of +1.5 and -1.5 recommended by Tabachnick and Fidell (2013), Mahalanobis values (Karaman, 2015) were calculated and the outliers were not included in the analysis. After the outliers were excluded, it was found that Skewness coefficient was -.70 (se=.18) and Kurtosis coefficient was .52, (se=.36). Based on this result, it was accepted that the data met the normal distribution assumptions (Tabachnick and Fidell, 2013) and CFA was performed via SPSS AMOS 23.00 (IBM, 2015) with the data of 186 participants. It can be said that Chi-square statistics (χ^2/df) and RMSEA, CFI, GFI values are mostly used to test the model fit in CFA (Karagöz, 2016). Kelloway (1998) states that a Chi-square (Chi-Square Goodness) value of <3 indicates acceptable fit, while a Chi-square value of <2 indicates perfect fit. On the other hand, Byrne (2016) advocates that Root Mean Square Error of Approximation (RMSEA) should be < .080, while Comparative Fit Index (CFI) should be > .90. Jöreskog and Sörbom (1993) stated that a model can be considered as acceptable when Goodness of Fit Index (GFI) is ≥.85. The present study also calculated SRMR (Gürbüz, 2021) which tests the residual covariances between the covariance matrices of the population and sample and the parsimony fit indices of PGFI and PNFI values. Values of SRMR< .08; PGFI≥ .50 and PNFI≥ .60 are considered as the indicator of acceptable fit (Byrne, 2016; Gürbüz, 2021).

When CFA was applied to the five factor and 25-item structure of the model obtained as a result of EFA, fit indices of the initial model were found to be χ^2/df = 1.76; RMSEA=.06; SRMR=.67 CFI=.89; TLI=.88; IFI=.90; GFI=.84; PNFI=.70 and PGFI=.69. While some authors consider these values within acceptable limits, some interpret that they are outside acceptable limits (Byrne, 2016; Çokluk et al., 2021; Gürbüz, 2021). Karagöz (2016) stated that required modifications can be made by examining modification indices and the model can show better fit with this method. Modifications made here should be suitable for theoretical structure. In this context, modification indices of BNSBCT were examined and a covariance was created between I24 and I14 in the love and belonging subscale and the analysis was repeated; however, it was found that some fit values were still not acceptable; therefore, modification indices were examined again and a covariance was created between I1 and I16 in the freedom subscale and the analysis was repeated; the goodness of fit values found in the analysis are shown in Table 4.

Table 4

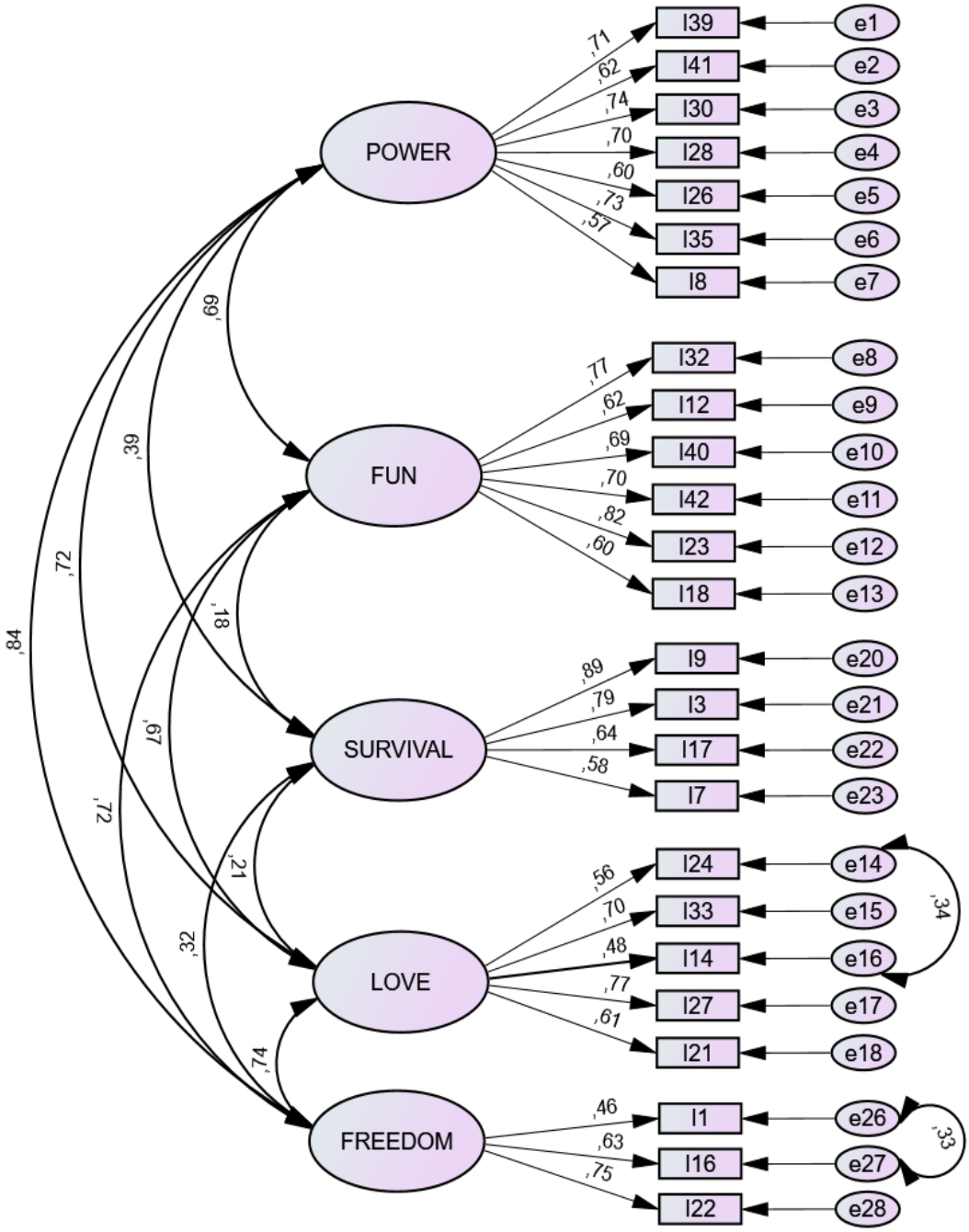
Confirmatory Factor Analysis Results of BNSBCT

χ^2	p	χ^2/df	RMSEA	SRMR	CFI	IFI	TLI	GFI	PNFI	PGFI
431.03	.00	1.64	.06	.64	.91	.91	.90	.85	.71	.69

When Table 4 is examined, it can be seen that BNSBCT has an acceptable fit in a five-factor and 25-item model. This model found with CFA is shown in Figure 2.

Figure 2

Confirmatory Factor Analysis Model of BNSBCT



As can be seen in Figure 2, five-factor and 25-item construct of BNSBCT was confirmed. According to the "Assessment of Normality" results revealed in the CFA and presented in Appendix-1, the Kurtosis and Skewness values of the majority of the items in the BNSBCT are in the range of +1 to -1. On the

other hand, since the Kurtosis and Skewness coefficients of the five items of the scale (I1, I16, I17, I14 and I24) are between the critical values of +3 and -3, it can be said that the multiple normality index is on the borderline (Gürbüz, 2021). Table 5 presents the item contents of the scale, the distribution of the items to the subscales, and the standard factor loads resulting from the CFA.

Table 5

Factor Loads for the Items of BNSBCT

Number	Items	Subscale	Factor Load
I39	I am considered as a successful person.	Power	.710
I41	I shape others' lives with my suggestions.	Power	.618
I30	I impress those around me with the things I do.	Power	.737
I26	I am a person consulted on many issues.	Power	.598
I28	After I accomplish something, I look for other accomplishments.	Power	.704
I35	I know that my position is good in my environment.	Power	.730
I8	People know me in the environments I enter.	Power	.573
I32	Regardless of how busy I am, I take time to have fun.	Fun	.773
I12	I play fun games.	Fun	.618
I42	I take care to spend time in environments where I can laugh and have fun.	Fun	.700
I40	I make time for my hobbies.	Fun	.695
I23	I do activities I can enjoy.	Fun	.816
I18	I get fun out of the situations I am in.	Fun	.603
I9	I try to consume healthy food.	Survival	.890
I3	I take care to have a balanced diet.	Survival	.788
I17	I stay away from habits that can endanger my health.	Survival	.642
I7	I take care of my sleep pattern.	Survival	.585
I24	I establish friendly relationships with my family.	Love	.561
I14	I feel like my family misses me when I am not with them.	Love	.495
I33	I can take the support of those around me about important issues.	Love	.698
I27	I feel like people around me don't like me.	Love	.768
I21	I know that there are enough people around me that I can share with.	Love	.607
I16	I can make my own choices about what is right and wrong for me.	Freedom	.631
I1	I can decide according to my own choices.	Freedom	.459
I22	I can choose who to work with in cooperative work to be done.	Freedom	.751

As can be seen in Table 5, the factor loads of the items in the power subscale of BNSBCT ranged from .573 to .737; the load of the items in the fun subscale is between .603 and .816; the factor load of the items in the survival subscale varies between .585 and .890; the factor load of the items in the subscale of love and belonging was between .495 and .768 and the factor load of the items in the freedom subscale varies between .489 and .792.

Convergent validity

In addition to construct validity, criterion dependent validity of the scale was also examined. In this context, convergent validity was performed. Türkdoğan and Duru's (2020) University Students Basic Needs Scale – Short Form (USBNS-SF) was used for convergent validity of BNSBCT. Both measurement instruments were applied successively to 64 adults aged 18 and older. Skewness and Kurtosis coefficients of the data obtained from the application of BNSBCT and USBNS-SF were calculated. Skewness coefficient of the data obtained from BNSBCT was found to be -.93 (se=.30) and the Kurtosis coefficient was found to be .76 (se=.59). Skewness coefficient of the data obtained from USBNS-SF was found to be -.44 (se=.30) and the Kurtosis coefficient was found to be .09 (se=.59). Based on these results, it was considered that the data met normality distribution assumption (Tabachnick and Fidell, 2013), the correlation between the results of both scales was calculated with Pearson's Product-Moment correlation coefficient and was found to be .71. Convergent validity of BNSBCT was examined by calculating Combined Reliability (CR) and Average Variance Extracted (AVE) values. According to the literature, for convergent validity, CR values should be higher than AVE value, AVE should be ≥.50 and CR should be ≥.60 (Bagozzi & Yi, 1988; Fornell & Larcker, 1981; Yaşlıoğlu, 2017). Table 6 shows the AVE and CR values of BNSBCT subscales.

Table 6

AVE and CR Values

Subscales	AVE (≥.50)	CR (≥.60)
Power	.45	.85
Fun	.50	.82
Survival	.54	.82
Love & Belonging	.40	.76
Freedom	.41	.56

As can be seen in Table 6, AVE and CR values of fun and survival subscales of the BNSBCT are above the theoretically specified limits. On the other hand, AVE value of the power and love and belonging subscales are below .50, while CR values are above theoretically specified .60. Both AVE and CR value of the freedom subscale is below the theoretically specified limits. In addition, CR values calculated for each of the subscales is higher than the AVE value.

Reliability of BNSBCT

BNSBCT was applied to 73 participants twice, with 21 days in-between. Skewness and Kurtosis coefficients of the data obtained from the applications were calculated. Skewness coefficient of the data obtained from the first application was found to be -.80 (se=.28), while Kurtosis coefficient was found to be .69 (se=.56). Skewness coefficient of the data obtained from the second application was found to be -.81 (se=.28), while Kurtosis coefficient was found to be. 33 (se=.56). Based on these results, it was accepted that the data met the normality distribution assumptions (Tabachnick and Fidell, 2013) and the correlation between the first and second application was calculated with Pearson Moments Correlation coefficient. The correlation coefficient calculated was. 83. Internal consistency reliability of the overall scale was calculated with McDonald's Omega coefficient (ω) and was found to be .92. Internal consistency of BNSBCT subscales was calculated with Cronbach Alpha coefficient. In

this context, Cronbach Alpha coefficient was found to be .77 for survival subscale, .82 for love and belonging subscale, .81 for fun subscale, .85 for power subscale and .66 for freedom subscale. Hinton, McMurray & Brownlow (2014) stated that a Cronbach Alpha coefficient between .50 and .70 could be interpreted as moderate reliability, a Cronbach Alpha coefficient between .70 and .90 could be interpreted as high reliability, and a Cronbach Alpha coefficient of .90 and higher could be interpreted as perfect reliability. In this context, it can be stated that the subscales of the BNSBCT have medium and high level of reliability. It can be stated that the overall scale has perfect internal consistency. Sencan (2005) stated that when correlation coefficient obtained with test retest reliability is between .80 and .100, it should be interpreted as "high" correlation. In the light of this information, it can be said that BNSBCT is a highly reliable scale.

Scoring and Interpretation of BNSBCT

In scoring BNSBCT, options ranging between 1 and 7 are taken into account for each item. One item of the scale is reverse scored. Positiveness of the response given to items in BNSBCT increases from 1 to 7. BNSBCT does not give a total score. An evaluation is made with the scores obtained from the subscales. Higher scores from each subscale show that the satisfaction for the need measured by that subscale increases.

RESULTS, DISCUSSIONS AND SUGGESTIONS

The aim of this study is to develop a measurement instrument for adults aged 18 and older to find out the satisfaction levels for five basic needs put forward in Choice Theory and to test the validity and reliability of the scale. For this purpose, face validity of the developed BNSBCT was first examined and the index calculated was found to be .91. This value shows that face validity of the scale is sufficient (Polit et al., 2007). Next, EFA was conducted to evaluate the factor construct of the measured structure. As a result of EFA, scale items were found to show a construct suitable for the five basic needs put forward by Glasser (1998). It was found that BNSBCT had a five-factor and 25-item structure. CFA was conducted for the five-factor structure obtained with EFA. As a result of CFA, it was found that the goodness of fit values obtained were within acceptable limits (Jöreskog & Sörbom, 1993; Hu & Bentler, 1999; Kline, 2011; Marsh, Balla, & McDonald, 1988). Convergent validity of BNSBCT was found to be as .70. Büyüköztürk (2021) stated that a correlation of ≥.30 is the indicator of the test's validity. In this context, it can be said that BNSBCT has high convergent validity. Cronbach Alpha coefficient of BNSBCT is .92, while test retest correlation coefficient is .83. Reliability values obtained with two different methods showed that the scale is a reliable measurement instrument (Nunnully & Bernstein, 1994). Psychometric properties of BNSBCT showed that this measurement instrument is a valid and reliable scale that can be used to find out the satisfaction levels of basic needs of individuals aged 18 and older. BNSBCT can be used to find out the satisfaction levels of needs for power, freedom, survival, fun, love and belonging in adults aged 18 and older.

Limitations and Recommendations

The results of the study should be evaluated by considering some limitations. The fact that there were fewer male participants in the study is one of the limitations of the study. According to educational statistics, 58% of the individuals between the ages of 25 and 64 have a primary education and/or lower degree. In the specified age range, the rate of undergraduates is 13.4% and the rate of graduate students is 2% in Turkey (Organisation for Economic Co-Operation and Development [OECD], 2021). In

other words, the rate of individuals with undergraduate and graduate degree are lower than the other educational levels. However, the fact that there was a higher rate of undergraduate and graduate students in the present study and the fact that the sample did not represent the individuals in lower educational level sufficiently is another limitation. Future research can be repeated in a sample representing individuals who graduated from secondary education or lower educational levels. The fact that AVE values of Power, Fun and Love & Belonging subscales and both AVE and CR values of the freedom subscale were not sufficient (Bagozzi & Yi, 1988; Fornell & Larcker, 1981) can be a limitation in terms of convergent validity. Finally, the research data were collected on online platform. The fact that the data were not collected from adults who were not on digital platform is also among the limitations of the study. Despite the aforementioned limitations, the results of the present study show that BNSBCT is a valid and reliable instrument to determine the basic needs of adult individuals. In this context, BNSBCT can be used to determine the level of meeting basic needs by professionals whose jobs are to help people and by researchers.

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APPENDIX-1

Assessment of normality (Group number 1)

Variable	min	max	skew	c.r.	kurtosis	c.r.
I22	1,000	7,000	-,899	-5,004	,885	2,464
I1	1,000	7,000	-1,353	-7,532	2,316	6,447
I16	2,000	7,000	-1,069	-5,954	,888	2,472
I7	1,000	7,000	-,354	-1,969	-,830	-2,311
I17	1,000	7,000	-1,098	-6,114	,604	1,680
I3	1,000	7,000	-,529	-2,945	-,032	-,089
I9	1,000	7,000	-,531	-2,959	-,045	-,124
I21	2,000	7,000	-,739	-4,117	-,098	-,272
I27	2,000	7,000	-,923	-5,137	,743	2,070
I33	3,000	7,000	-,631	-3,511	,041	,113
I14	1,000	7,000	-1,193	-6,641	1,074	2,990
I24	1,000	7,000	-1,536	-8,552	2,554	7,109
I18	1,000	7,000	-,476	-2,648	-,388	-1,081
I23	3,000	7,000	-,585	-3,259	-,382	-1,063
I40	2,000	7,000	-,213	-1,186	-,638	-1,777
I42	2,000	7,000	-,868	-4,831	,280	,779
I12	1,000	7,000	-,375	-2,087	-,737	-2,052
I32	2,000	7,000	-,139	-,776	-,605	-1,683
I8	1,000	7,000	-,241	-1,344	-,681	-1,895
I35	3,000	7,000	-,436	-2,428	-,188	-,524
I28	1,000	7,000	-,913	-5,083	,921	2,565
I26	1,000	7,000	-,646	-3,599	,575	1,600
I30	2,000	7,000	-,320	-1,782	-,635	-1,769
I41	1,000	7,000	-,628	-3,499	,573	1,595
I39	3,000	7,000	-,364	-2,028	-,616	-1,714
Multivariate					137,392	25,499

Author Contributions

The authors contributed equally for writing the article, conceptualization of the article, data collection, analysis and discussion.

Conflict of Interest

No potential conflict of interest was declared by the author.

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The Effect of Cognitive Behavioral Play Therapy Based Psycho-Education Program on the Level of Violent Content Digital Game Addiction and Aggressiveness

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Abstract

Cognitive-behavioral play therapy-based psycho-education program is important because it shows that this type of intervention can reduce levels of violent content digital game addiction and aggressiveness in adolescents. This has implications for the development of effective prevention and intervention strategies and highlights the benefits of integrating play therapy and psycho-education techniques in treating addiction and aggression in youth. The main aim of this investigation is to examine the effect of cognitive-behavioral play therapy-based psycho-education program on the level of addiction to digital games with aggressive content and aggressiveness in children. The study was conducted with 219 students from 4th grade in a primary school in Turkey in 2020. The research, that has an experimental design, has one independent variable which is the cognitive-behavioral play therapy-based psycho-education program and two dependent variables which are digital game addiction and aggressiveness scores. Data was collected through "The Computer Game Addiction Scale for Children" and "Aggressiveness Scales". Data was analyzed by using the SPSS 22.00 packet program. According to the study findings, cognitive-behavioral play therapy-based psycho-education program was found to have a significant effect on the level of digital game addiction and aggressiveness in the experimental group. However, a positive and high-level correlation was found between digital game addiction and aggressiveness through the correlation analysis. Finally, the findings of the study were discussed in the light of the relevant literature, and recommendations were made for further research.

Keywords

Cognitive behavioral play therapy, Psycho-education, Digital game addiction, Aggressiveness, Children.

Ethics Committee Approval: Ethics committee permission for this study was obtained from Sakarya University Ethics Committee with the decision dated 04.11.2020 and numbered 28/17.

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Note: This study is derived from a doctoral dissertation prepared by the first author under the supervision of the second author.

INTRODUCTION

It can be assumed that one of the most important and an influential invention of the post-modern world is the innovation of the internet. A significant purpose of the internet is also to play online games depending on the age and gender groups, even adults. Games are a way of expressing thoughts and emotions and experiences by children (Crenshaw & Stewart, 2017). Games played by children are basically divided into two separate areas; physical and virtual. In this study, the subject will be discussed based on games played in the virtual platform. Ögel (2012) classifies digital games as action, adventure, fighting, riddle, entertainment, role, simulation, sports, strategy and mission games. Another research by Burak and Ahmetoğlu (2015) found that 64.25% of students playing digital games prefer violent games in their study at primary school level. According to these study findings, it can be said that the rate of users who prefer violent games among these game types has increased significantly.

Apart from game types with violent content, there is a crucial matter with the limit of games. Twenge (2018) has asserted that adolescents spend 1.5 hours with digital games in a routine day. Another research realized by ESA (2018) showed that 30% of digital gamers are individuals under the age of 18, which is accepted by the UN (1989) as a child. Judging by the type of game played, fighting and action games account for 35% and 28% of all digital games. In this context, it can be said that the games that children prefer in the digital platform mostly contain violence and action. Furthermore, both Anderson and Dill (2000) and Gentile et al. (2004) found in their studies that adolescents who prefer violent digital games exhibit more aggressive behaviors and have lower school success. The results of these studies prove that the preferred game type is related to the behavioral style.

On the other hand, there are some statistically proven studies about the positive aspects of digital games played by children at the same time. Entertainment Software Association (ESA) (2018) states that 55% of video game players connect with their friends thanks to these games, and 46% contribute to spending time with their families. Actually, it is not a big problem that a child plays virtual games in the digital environment exactly, the main problem is the unlimited duration of games. Individuals, especially children, can lose their individual control in terms of time and content with the effect of the attractiveness of the game while playing games in the virtual environment. Ofcom (2018) has stated that 74% of children aged 8-11 play computer games and spend an average of 10 hours a week playing online games. If the game is played in an unlimited way, by losing track of time, this can also lead to an addiction problem. Game addiction can be defined as excessive gaming, which negatively affects health, academic faculties, and daily life of children (Horzum, 2016). The problem here is not with playing the game but with the style of game and the duration dedicated to it.

Although addiction is generally considered as an extreme tendency towards any chemical substance such as cigarettes or alcohol in the psychology literature, it is possible for the individual to spend excessive time on a certain object without any drugs (Griffiths, 2012). Therefore, technology incorporates addiction elements that can be considered in this context because it can turn into an addictive behavior. However, at the 72nd World Health Council meeting held in 2019, WHO (2021) included digital gaming addiction, which has similar epidemiological, neurobiological, and symptomatic similarities with gambling addiction, into the category of disorders related to behavioral addictions. Griffiths (1996) claims that the concept of behavioral addiction is not quite different from other substance addictions in terms of dependency and that it should be treated in the same manner.

Behavioral addiction consists of six components: attractive goals at a distance, irresistible and unpredictable positive feedback, an increased sense of growth and progress, tasks that gradually become more difficult over time, tensions that require resolution, and strong social connections (Alter, 2018). With observations and statistical instruments, most of these components can be shown among the characteristics of individuals with digital game addiction.

Significant study around the world has put forward game users' expressing aggressive behavior (Kılıç, 2019), a positive relationship between obesity and digital games (Muslu & Gökçay, 2019), and social anxiety in game users (Karaca at. all, 2016). Voltan Acar (2015) describes psycho-education as groups which aim to change target behavior with cognitive-oriented techniques. Apart from this, Yalom (2015) assesses psycho-education as closed groups because of its construction of time and person limitations.

The use of play in therapy was first discussed by the pioneers of child psychotherapists such as Anna Freud (1928, 1964, 1965), Margaret Lowenfeld (1935, 1970) and Melanie Klein (1961, 1987). The term of play therapy is defined by Association of Play Therapy (2021) as the systematic use of a theoretical model to establish an interpersonal process using the therapeutic powers of play in order to help clients prevent or solve psycho-social difficulties and achieve optimal growth and development.

Aggressiveness

Aggressiveness is one of the most referred words that relate to digital games in the studies. Myers (2010), who explains aggression with instinctive theory, frustration theory, and social learning theories, defines physical or verbal behavior that causes harm to someone as aggression. Gerrig and Zimbardo (2018) on the other hand, define aggression as behavior that would cause psychological or physical harm to others. Accordingly, physical aggression represents situations where the child gets into a fight or hits, bites, or kicks another child, while social aggression refers to situations where the child spreads bad rumors about someone else or makes others dislike a particular classmate.

In the meantime, some researchers evaluated the concept of aggression under the category of behavioral disorders (Austin & Sciarra, 2012). Apart from that, Dattilio and Freeman (2017) who are from the school of thought that put forward cognitive psychology theory, dealt with the term aggression mainly in two groups: reactive and proactive. Reactive aggression is the type of aggression created by anger and frustration; whereas in proactive aggression, physical pain is not the ultimate goal. To illustrate this situation, removing the device on which the child wants to play digital games may cause reactive aggression. In this context, just like other psychological problems, aggression also has some treatment plans in order to reduce the bad effects on children who bear any potential of impulsive aggression. Although aggression can be treated as a single disorder or in relation with others such as digital game addiction, treatments can be developed. Cognitive or behavioral approaches, and family interventions are the main components of a comprehensive program designed for the treatment of aggressive children. Therefore, in this study cognitive-behavioral play therapy was used for addiction to digital games with aggressive content.

Cognitive-behavioral play therapy (CBPT)

Knell (2009) shaped the principles of cognitive-behavioral play therapy by adapting to Beck's cognitive therapy principles, as presented below;

Cognitive-behavioral play therapy is based on the cognitive model of emotional problems.

Cognitive-behavioral play therapy is short and time limited.

The therapeutic relationship is a necessary condition for the effectiveness of cognitive-behavioral play therapy.

Cognitive-behavioral play therapy is based on collaboration between the therapist and the child.

Cognitive-behavioral play therapy uses the Socratic questioning method for the purpose of externalizing the client.

Cognitive-behavioral play therapy is structured and goal-directed.

Cognitive-behavioral play therapy is problem-centered.

Cognitive-behavioral play therapy is based on an educational model.

Cognitive-behavioral play therapy uses an inferential and deductive technique.

Cognitive-behavioral play therapy uses homework in therapy sessions effectively.

In addition to these, CBPT uses cognitive restructuring, problem solving, systematic desensitization, role-playing, exposure, relaxation techniques, bibliotherapy and psycho-education in the therapy phase with children (Knell & Dasari, 2009). All these therapeutic techniques have been used in available research when the psycho-education program was conducted. Besides that, Knell and Dasari (2016) suggested in a different study that initiation, evaluation, treatment, and termination stages were taken as basis when applying CBPT, respectively. Finally, the main purpose of this study is to decrease the level of digital game addiction and aggressiveness in the primary school children.

METHOD

This study was carried out in a mixed practice of 2x3 (experimental/control group X test-posttest-follow-up test) of the pre-group real trial types. The 1st factor of the design is independent (experimental-control groups), the 2nd factor of the design is three repetitive measurements (pre-post-follow-up test) of the dependent variable (Büyüköztürk et al., 2008). The independent variables are changed by the experimenter while the dependent variable is the response measurement of the experiment, which depends on the response of the subject in the changing environment (Kantowitz et al., 2009). The independent variable of the study is the psycho-educational program based on CBPT, and the dependent variable is the scores obtained from the scale of computer game addiction in children and aggression scale.

Participants

The participants of this study were determined by applying the Game Addiction Scale for Children to 219 students attending 4th grade of primary school. The control and experimental groups were determined by assigning 30 people with the highest scores in the risky and dependent category for the study group, one by one, to the 1st and 2nd groups from 2 separate groups. In order to avoid interaction between individuals, attention was paid to the fact that the class branches of the students were different. In the preliminary interview with 30 students, the scope and content of the study to be carried out were explained in detail. 5 of the 15 students determined as the control group were excluded from the study group in line with their own or their families' wishes. On the other hand, 3 people from the experimental group were excluded from the study group because they did not volunteer and 2 of them did not attend the first 3 sessions after the psycho-education program started.

Thus, the study was conducted with 20 participants, all of whom were male, 10 in the experimental group and 10 in the control group.

Procedure

All parents were informed about the purposes and the process of the study. In the beginning of the study, participants also completed all the instruments that are used in the study in their natural environment as a pretest. After 10 weeks, the psycho-education program was completed and the posttest procedure was implemented to the participants. Subsequently, after 3 months, the follow-up test was realized in order to test the effect of the psycho-education program in the long term. The time and subject table that was prepared for the implementation process of the CBPT-based psycho-education program is presented below.

Table 1

Group session number, name, date and duration

Session number	Session name	Date	Duration
Parent session 1	Giving information on plan	02/01/2020	90 minutes
Pre-interview	Information and contract	03/01/2020	30 minutes
Session 1	Meeting each other	06/01/2020	60 minutes
Session 2	Exposure to the problem	13/01/2020	60 minutes
Session 3	ABC technique	03/02/2020	60 minutes
Session 4	Effective time management	10/02/2020	60 minutes
Session 5	Improve motivation	17/02/2020	60 minutes
Session 6	Creating behavioral change	24/02/2020	60 minutes
Session 7	Acquisition of self-management	02/03/2020	60 minutes
Session 8	Behavior orientation	09/03/2020	60 minutes
Session 9	Behavior reinforcement	11/03/2020	60 minutes
Session 10	Termination of psycho-education	19/03/2020	60 minutes
Parent session 2	Evaluation	23/03/2020	60 minutes

Instruments

At the beginning of the study, a demographic questionnaire was used in order to determine some features of the participants like age, gender and class. Furthermore, Computer Addiction Scale for Children by Horzum, Ayas and Çakır-Balta (2008) and Aggressiveness Scales (Şahin, 2004) were used in order to determine the participants' level of game addiction and aggressiveness, in beginning, ending, and follow-up stages of the psycho-education program.

Computer Game Addiction Scale for Children (Horzum, Ayas, & Çakır-Balta (2008)

The purpose of CGASC, which was developed by Horzum et al. (2008), is to determine the computer game addictions in primary school and above. The scale, consisting of a total of 24 items, was conducted with 460 students from different socio-economic statuses attending in Trabzon. The scale has been determined as 4 factors: not being able to give up playing games on the computer and being disturbed when blocked, keeping the computer game alive in one's dreams and associating it with real life, disrupting tasks due to playing computer games, and preferring playing games to other activities.

Lastly, with the value of .85, Cronbach's Alpha internal consistency coefficient of the scale meets the psychometric qualities.

Aggressiveness Scales (Şahin, 2008)

The aim of this measurement tool developed by Şahin (2008) is to determine the aggression levels of children aged 10-11 based on social learning and cognitive theory. The scale, consisting of 18 items, was carried out with a total of 450 students attending 4th and 5th grades in Primary Schools in the city of Burdur, which were determined by cluster sampling method. The validity and reliability scores, calculated as .77 Cronbach's Alpha coefficient, show that the scale can be used to determine the aggression levels of children aged 10-11.

Statistical Analysis

The collected data was analyzed with the SPSS 22.00 package program. In the analysis of the data, the value of .05 was taken as the significance score. In this context; a two-factor ANOVA test was used to decide whether the change observed in repeated measures of the effect of the experimental procedure on the dependent variables (game addiction and aggression) was of significant difference between the experimental and control groups. Therefore, statistical analyses were performed against the violation of the assumptions (normal distribution, homogeneity, and sphericity) of the two-factor ANOVA test of the data set (Shavelson, 2016). In the analysis process of the research design, Shapiro-Wilks test for normal distribution, Levene test for homogeneity, Box's M for equality of covariance, and Mauchly's Test of Spherecity analysis tests were performed to decide the independence of difference scores calculated in terms of sphericity.

Ethical Principles

Ethics committee permission for this study was obtained from Sakarya University Ethics Committee with the decision dated 04.11.2020 and numbered 28/17.

FINDINGS

Table 2

Shapiro-Wilks Normality Test Results on Digital Gaming Addiction

Dependent Variable	Group	Measure	Shapiro-Wilks Statistic	sd	p
Game addiction	Experiment	Pre-test	.758	10	.004
		Post-test	.959	10	.773
		Follow-up test	.884	10	.144
	Control	Pre-test	.866	10	.089
		Post-test	.939	10	.547
		Follow-up test	.929	10	.442

According to Shapiro-Wilks normality test, it will be observed that the dependent variable has a normal distribution in all subgroups (except from pretest of experimental group) separately ($p > .05$). The results related to homogeneity assumption have been presented in Table 3.

Table 3

Levene, Box's M and Spherecity Test Results on Homogeneity of Variances and Equal Covariances of Groups

Groups	Variable	Levene				Box's M			Spherecity Test	
		F	sd1	sd2	p	İstatistik	F	p	Mauchly's W	p
Experiment and Control	Pre-test	.127	1	18	.725	4.954	.674	.670	.878	.330
	Post-test	.051	1	18	.828					
	Follow-up	.103	1	18	.752					

When Table 3 is examined, it will be seen that the variances of the scores obtained from the groups were equal through Levene test (p > .05), the covariances of the groups are equal for binary combinations of measurement sets via Box's M test (p > .05), and spherecity assumption test with Mauchly's W (p > .05). When all these findings are evaluated in general, it can be concluded that the data set meets the two-factor ANOVA assumptions.

Table 4

Arithmetic Mean and Standard Deviation Values of Digital Game Addiction Scale for Experimental and Control Groups

Group	Pre-Test			Post-test			Follow-up Test		
	N	$\bar{x}$	SS	N	$\bar{x}$	SS	N	$\bar{x}$	SS
Experiment	10	62,70	10,63	10	45,30	9,26	10	40,70	10,17
Control	10	66,90	10,60	10	61,20	11,24	10	67,90	8,98

When Computer Game Addiction Scale is examined in the way of pretest, posttest and follow-up test scores for experimental and control groups; pretest scores mean for experimental group is X = 62.70, posttest score mean is X = 45.30, and follow-up test mean is X= 40.70; pretest scores mean for control group is X = 66.90, posttest score mean is X = 61.20, and follow-up test mean is X = 67.90. According to these findings, when the mean score of computer game addiction of the experimental group is compared with the pretest scores, a significant decrease is noticed in the mean scores of the posttest and follow-up tests. In terms of control group, on the other hand, although there was a very low decrease in the posttest mean scores when compared to the pretest, follow-up test mean scores increased again, reaching a higher mean than the pretest mean scores. Although, an inference about the increasing and decreasing in the mean scores of the findings in the descriptive analysis table is possible, it was obtained from ANOVA tests for repeated measures whether this difference is significant.

Two-factor ANOVA test results of the data set whose assumptions were met have been presented in Table 4.

Table 5

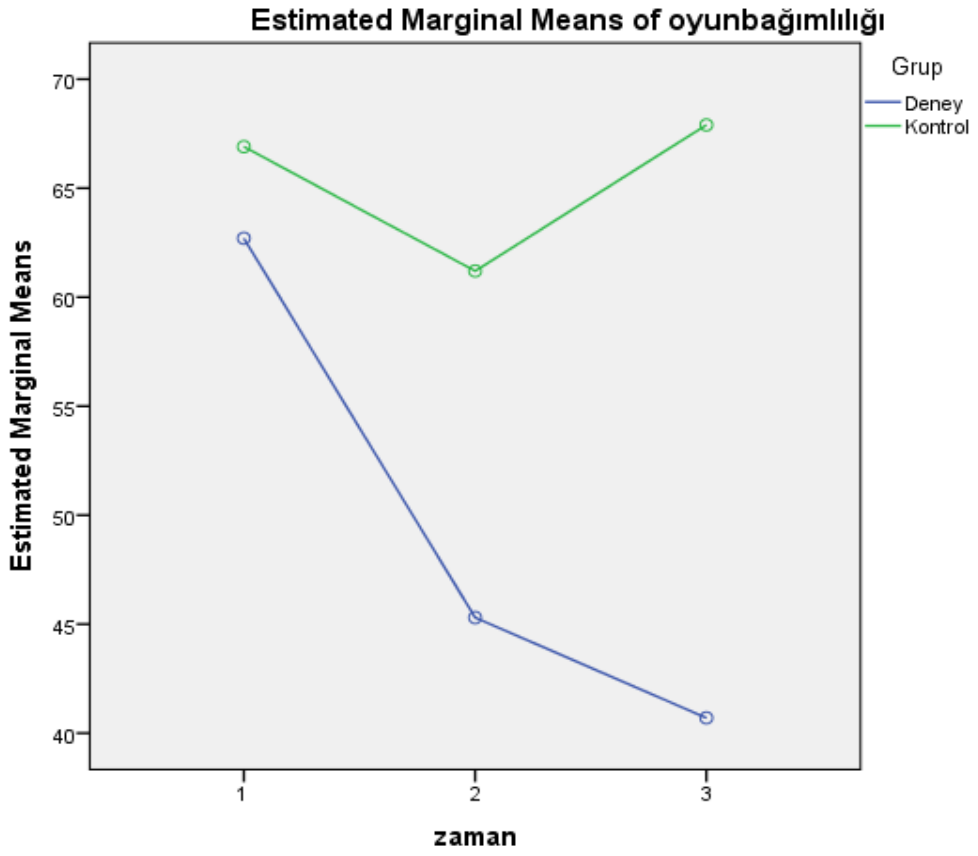
ANOVA Results of Game Addiction Scale Pretest, Posttest, and Follow-up Test Scores

Resource of Variances	Sum of Square	Sd	Average square	F	*p*	Partial Eta-Kare
Intergroup intervention	2380,950	19				
(Experiment-Control)	1242,939	1	1242,939	19,660	,000	,522
Error	1138,011	18	63,223			
In-group	6290	20				
Time (Pretest-Posttest-Follow-up)	2668,050	1	2668,050	16,546	,001	,479
Intervention*Time	638,450	1	4,245	7,189	,015	,285
Error	2902,500	18	161,250			
Total	8670,95	39				

Partial eta-squared value was found as .479 in ANOVA table. It can be said with this value that the %47,9 of the variation in the dependent variable of computer game addiction was explained by the time variable.

Figure 1

Game addiction mean score graph of the experimental and control groups from the pretest, posttest and follow-up measurements



It is seen at the Table that cognitive behavioral play therapy-based psycho-education program has a decreased effect on the digital game addiction level of experimental group as after experiment and following process. This change is not necessary for the control group. Consequently, findings related to the digital game addiction support the idea of psycho-educational program is effective in decreasing the level of digital game addiction.

Table 6

Paired Comparison of Aggression Pre-Post and Follow-Up Tests Scores of Experimental and Control Groups (Bonferroni Compatible) Post-Hoc Analysis Results

		Experiment		Control	
		Pre-test Average Fark I-J	Post-test Average Fark I-J	Pre-test Average Fark I-J	Post-test Average Fark I-J
Experiment	Pre-test		2.100	-4.200	
	Post-test	-2.100			-4.200
Control	Pre-test	4.200			2.100
	Post-test		4.200	-2.100	

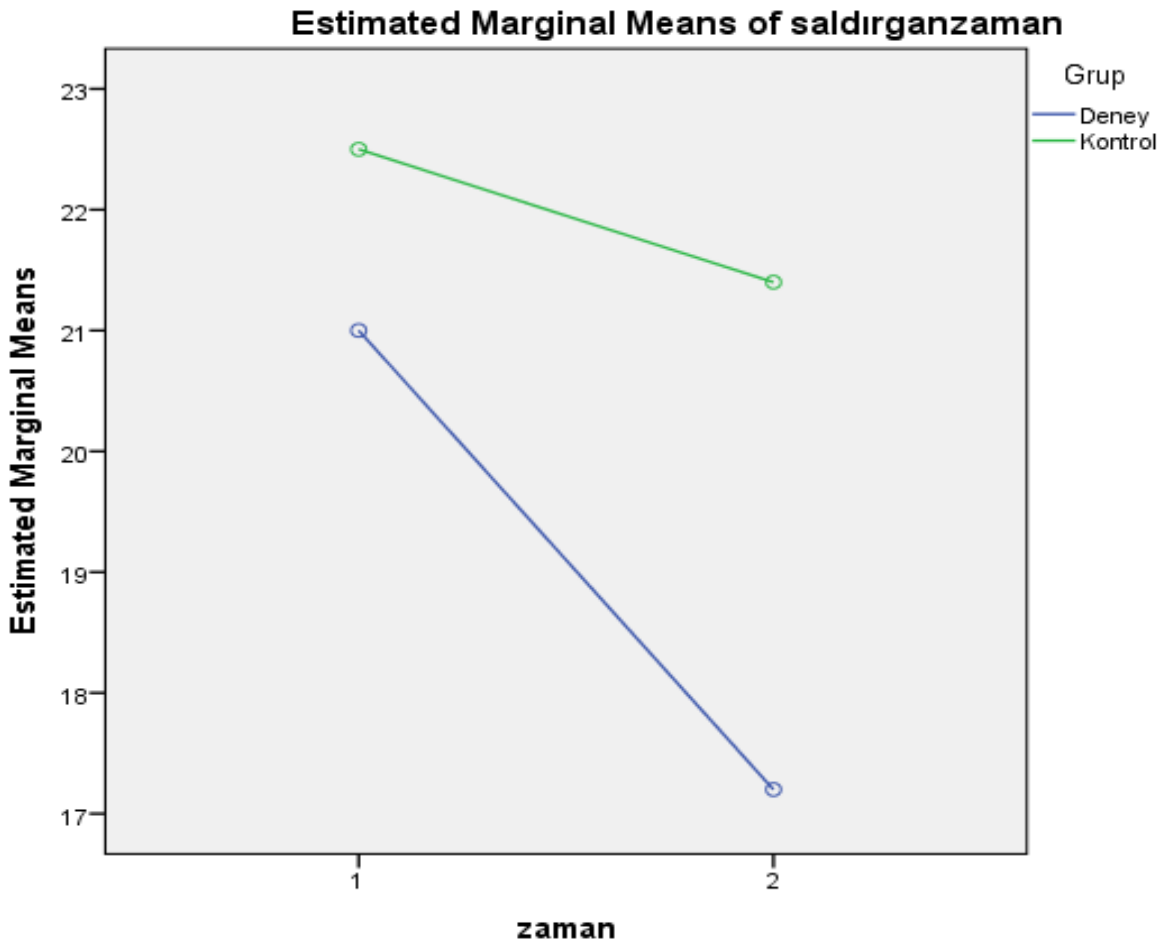
Looking at Bonferroni compatible Post-Hoc test in Table 19, although the difference between the mean score obtained from the experimental group pre-test measurements (X = 19.30) and the post-test mean scores (X = 17.20) is not significant, it is seen that there is a decrease. In other words, it can be said that the experimental process is partially effective in reducing the aggression level of the experimental group. According to the result, although the experimental process is not significant, it has been reduced the level of aggression in the experimental group (p<.05). Similar with the experimental group, although there was a difference between the mean score obtained from the pre-test measurements (X = 23.50) and the post-test mean score (X = 21.40) for the control group, it was found that this difference is not significant. When the mean scores of the experimental and control groups in terms of pre-test (X = 19.30/X = 23.50) and post-test (X = 17.20/ X = 21.40) are compared, it is seen that there is no significant difference between the measurements of the groups (p<.05).

When all these data were evaluated; although the experimental procedure could not show a significant effectiveness in terms of the experimental and control groups, it was observed that there was a decrease in favor of the post-test between the first and the last test on the experimental group.

The multiple comparison findings between the measurements given in Table 6 are also presented in the Figure 2 interaction graph below.

Figure 2

Aggressiveness mean score graph of the experimental and control groups from the pretest, posttest and follow-up measurements



Looking at the Figure 2, it has been observed that there is a certain decrease in the aggression scores of the individuals in the experimental group after the experiment procedure compared to the results beforehand. Although there is an effect of the experimental intervention, control group has also a similar line of experimental group in the graph.

When all these findings were evaluated, it can be said that psycho-educational program has an effect on aggression level of the experimental group. In terms of the control group, there is a decrease in the level of aggression yet it is not same as the experimental group. Consequently, all these results have displayed that cognitive behavioral play therapy-based psycho-educational program has a reduced effect on the aggression level but it is not known whether the effect goes on following the intervention process.

However, there can be a relationship between terms of digital game addiction and aggression as dependent variables of the research. In other words, children who are playing aggression contented digital games may also have some aggressive characteristics. Pearson correlation analysis was used to

determine the relationship between digital game addiction and aggression as dependent variables of the research. Correlation data related to both variables has been presented in Table 7.

Table 7

The Relationship between The Variables of Digital Game Addiction and Aggression Level

Variances	Analyze Type	Game Addiction	Aggressiveness
Game Addiction	Pearson Correlation	1	.538
	Significance Value	-	.014*
Aggressiveness	Pearson Correlation	.538	1
	Significance Value	.014*	-

*= $p < .05$

The relationship between digital game addiction and aggression was examined via Pearson Moments Coefficient. If the Table is observed, it will be seen that there is a value of r = ,538 and $p < .05$ between digital game addiction and aggression variables. According to these results,

It can be said that there is a significant positive relationship between both variables. Pallant (2017) accepts .50 and more as a significantly strong relationship. Therefore, it can be determined that there is a significant and strong positive relationship between digital game addiction and aggression.

Ultimately, Table 7 has shown that these results support the research's hypothesis that there is a relationship between digital game addiction and aggression. In other words, digital game addictive children can have a high level of aggression. Yet, it cannot be said that digital game addiction affects directly the aggression in children.

DISCUSSIONS

Basically, it can be observed that the children who participated in the psycho-education program, which was developed to reduce the level of digital game addiction and aggressiveness in children, showed a significant decrease in the level of digital game addiction compared to those who were not included in the program. When the literature was reviewed, no study was found to reduce the level of digital game addiction with the cognitive-behavioral game therapy-based psycho-education program. In the thesis study by Kaşıkçı (2020), it was also seen that there was a statistically significant difference between the groups that played and did not play violent games in terms of the level of trait anger. However, it is possible to come across studies such as the effect of cognitive-behavioral therapy on the level of digital game addiction or motivational interview techniques on the level of game addiction. To illustrate that, the research findings are consistent with the findings of a research conducted using the psycho-educational model developed based on the motivational interview technique (Özcan, 2018).

One of the other findings is that there is a high level of correlation between the concepts of digital game addiction and aggression. This situation can also be evaluated as the aggression levels of children with high levels of digital addiction may also be high. When the literature is reviewed, supportive evidence is seen. Güvendi et al. (2019) conducted a study with secondary school students and found a positive and significant relationship between aggression and digital game addiction. Furthermore,

Starcevic et al. (2011) also found a non-significant relationship between problematic video game use and psychopathology. Although the psychopathological status of the concept of aggression is discussed, considering its harmful effects on children's mental health, it can be considered a study that supports the current research in terms of the negative consequences of violent digital games.

In light of all these findings and discussion; once fundamental conditions are controlled such as the absence of violence in the content, playing under parental control, setting a time limited considering the developmental stages of children, sleep time, and homework, the digital games can be used to contribute to children's academic and social development. In this context, while Yeşilay (2018) emphasizes that those children under the age of 2 should have a screen-free life; it suggests that students in the first 4 years of primary education can spend a maximum of 45 minutes a day with games and entertainment on the internet and that there should be no more.

According to Elkind (2011) computer games are a part of our environment and they have both good and bad sides. In the case of preschool and school-age children, computers can serve as entertainment as well as education if used judiciously. Moreover, many studies have shown that digital games include stability (Shute et al., 2015; Ventura et al., 2013), spatial skills (Dorval and Pepin, 1986; Feng et al., 2007; Green and Bavelier, 2003), problem-solving skills (Adachi et al., 2003; Willoughby, 2013; Prensky, 2012). Finally, digital games are not merely harmful for children, yet some precautions could be taken by the parents in order to benefit their children optimally by filtering negative effects of digital games.

Limitations

Considering basic scientific criteria, this research bears some limitations. First of all, the study is limited with a sample from a certain area that can be related to easy access to target sample. Another limitation can be counted as the gender of participants that consists of boys because of their selection of aggressive digital games when the researcher surveyed game kinds. In addition to that, the study is limited with 10 cognitive-behavioral play therapy psycho-education sessions. However, the research results may have been affected by the COVID-19 period which people had to spend most of their times at home using technological devices for some reasons related to the work, education and, especially entertainment.

Conclusions

Taking everything into consideration, the study has some crucial conclusions that affect the life of children in several ways. First of all, cognitive-behavioral play therapy-based psycho-education program was found to be effective in reducing digital game addiction and aggression levels of primary school 4th-grade students. In addition to this, during the implementation of the psycho-education program, it was observed that the participants developed a controlled perspective on digital games and aggression. Moreover, after the cognitive-behavioral play therapy-based psycho-education program, parents shared their observations that children showed a relatively more controlled approach to digital games and decreased aggressive impulses. According to these statistical results and findings, it can be accepted that the cognitive-behavioral play-based psycho-education program is effective reducing the level of digital game addiction and aggression in children. To sum up, the psycho-education program can be implemented to different samples in the future in order to increase its scientific and empirical validity.

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Interpretations of Pre-service Elementary Mathematics Teachers on the Functions of Non-Textual Elements: Case Study on Algebra Learning Area

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Abstract

The study aimed to investigate how pre-service elementary mathematics teachers perceive the intended use of non-textual elements in an algebra content area of an eighth-grade mathematics textbook. Non-textual elements in this qualitative exploratory case study refer to visual representations consisting of components that are not only verbal, numerical, or symbolic representations. Data were collected from thirty-one undergraduate students through a task-based written questionnaire including seven non-textual elements on the algebra learning domain. Data analysis was conducted using a content analysis approach to generate themes and uncover previously unspecified patterns. The results showed that pre-service teachers' interpretations of non-textual elements could be categorized into ten themes: (i) attractiveness, (ii) organizing, (iii) embodiment, (iv) informativeness, (v) reasoning, (vi) conciseness, (vii) essentiality, (viii) decorativeness, (ix) contextuality, and (x) connectivity. Pre-service teachers were found to have diverse but sometimes overlapping interpretations of the functions of each non-textual element. However, the functional diversity of non-textual elements may have differentiated their interpretations, as visual literacy skills and strategies are required to interpret the intended use of non-textual elements. Therefore, in order for pre-service mathematics teachers to better understand the functions of non-textual elements, various teaching approaches should be developed to support pre-service teachers' visual literacy, and these approaches to visual literacy should be incorporated into teacher education and professional development.

Keywords

Non-textual elements, mathematics textbook, algebra learning area, pre-service elementary mathematics teachers.

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INTRODUCTION

Attracting students' visual attention is essential for teaching, communicating key concepts, and engaging students emotionally with course content (Araya, Farsani, & Hernández, 2016). Since visual representations can capture students' attention and have a positive impact on learning outcomes (Levin & Mayer 1993; Pettersson, 1990; Woodward, 1993), it can be seen that more images, illustrations, and diagrams are included in textbooks than in the past (Bazerman, 2006; Boling, Eccarius, Smith & Frick 2004). On the other hand, it has also been reported that visual images, particularly in science and reading books, can sometimes make it difficult for students to understand the content and even lead to confusion and misinterpretation of the text (Watkins, Miller & Brubaker, 2004). However, due to the abstract nature of mathematics, it is argued that representing or illustrating mathematical concepts or situations in different ways helps students develop their abstract thinking skills and contributes to mathematical understanding (National Council of Teachers of Mathematics [NCTM], 2014).

Visualization is not a new method for mathematicians, and they have long been aware of this method and have made great efforts to take advantage of it (Borwein & Jörgenson, 2001). Visualization makes it easy to understand how mathematical ideas are structured and how they relate to each other (Farmaki & Paschos, 2007). Since representations are directly related to both mathematical content and the learning process, they are considered to be effective in the formation of an individual's concept image, mathematical communication, and reasoning (Hershkowitz, Arcavi & Bruckheimer, 2001; Tall & Vinner 1981). Therefore, in addition to textual elements such as written texts, mathematical signs, and symbols, non-textual representations such as figures, diagrams, and various pictures are believed to play an important role in teaching mathematics (Arcavi, 2003; Brenner et al., 1997; Herman, 2007; Pape & Tchoshanov, 2001; Stylianou & Silver, 2004).

Algebra is a critical content area of focus in mathematics teaching as it provides important opportunities for the development of mathematical thinking, reasoning, and problem-solving skills (Van de Walle, Karp & Bay-Williams, 2012). NCTM's vision for school mathematics recognizes the importance of algebra and highlights why all students should learn algebra. First of all, algebra uses abstract structures and the principles of these structures in solving problems expressed with symbols. Besides, the ideas contained in the algebra standard are an important component of the school mathematics curriculum and help unify its content areas. For example, most of the symbolic and structural emphasis in algebra is built on students' knowledge of numbers. Algebra is also closely related to geometry and data analysis. In addition, algebraic competence is important in individuals' further education and later in their working lives. Moreover, algebra represents patterns in our daily lives and generalizes arithmetic. In other words, it is the language of generalization used to create a systematic representation of patterns and relationships between numbers and objects, to analyze change, and to model real-world events (NCTM, 2000, 2018).

The concepts of algebra can be studied and communicated through representations, enabling students to interpret relationships among quantities and make sense of symbols (Kieran, 2004). Being successful in algebra depends on algebraic thinking, defined as the individual's ability to generalize about mathematical operations and relationships/patterns, to make assumptions from these generalizations, and to discuss and express them (Kaput, 1999). Since algebraic thinking is expressed as the use of mathematical symbols and tools to represent verbally expressed mathematical knowledge with figures, tables, graphs, and equations by selecting the necessary information from the given problem situation (Herbert & Brown, 1997), there needs to be the effective use of multiple representations and

relating these representations with each other in teaching algebra. Indeed, the use of representations in mathematics teaching is widely considered necessary, because abstract mathematical ideas, concepts, or relationships can only be accessed through representations and their effective use in teaching (Duval, 2006). On the other hand, a variety of representations appear to be readily available and widely used in curriculum materials, but research encourages educators to carefully examine both their benefits and limitations to support students' learning (Kamii, Lewis & Kirkland, 2001), rather than having a high expectation that the anticipated functions of these representations will somehow occur spontaneously (Ball, 1992). Mathematics curriculum materials include not only textual elements such as standard text, mathematical signs and symbols, but also various non-textual elements such as figures, tables, graphs, diagrams, pictures, images, and illustrations (Filloy, Rojano & Puig, 2008). Teachers are also expected to constantly interact with curriculum materials to assist and guide their teaching, including textbooks, teacher guides, student worksheets, and other types of resources (Stein, Remillard & Smith, 2007). However, if teachers interpret and apply representations inappropriately, incorrect messages may be transmitted and then basic mathematical concepts may be distorted, which can further confuse students (Bosse, Lynch-Davis, Adu-Gyamfi & Chandler, 2016). For this reason, teachers need to use various non-textual elements effectively for students to learn mathematics meaningfully. Despite the importance of non-textual elements in teaching and learning mathematics and the potential for misuse, their features and roles in mathematics curriculum materials are still elusive for many teachers, especially for prospective teachers (Lee & Ligocki, 2020). Therefore, this paper aims to explore pre-service teachers' interpretation of the functions of non-textual elements in a mathematics textbook. More specifically, the study attempts to investigate how pre-service elementary mathematics teachers perceive the characteristics and roles of non-textual elements selected from an algebra content area of an eighth-grade mathematics textbook.

Literature Review and Conceptual Background

In this study, we are particularly concerned with the intended use and overall quality of non-textual elements referring to visual representations consisting of components that are not purely verbal, numerical, or mathematical symbolic representations (Kim, 2009). For example, the equation $a^2 + b^2 = c^2$ used in the Pythagorean Theorem is not a non-textual element, as it consists only of symbolic representations. However, if it is illustrated with a right triangle picture in which the necessary symbols and signs are used, the picture is a non-textual element because it is not a purely symbolic representation despite some symbols and signs it contains. Kim (2012) emphasizes that research on visual representations in mathematics textbooks usually focuses on mathematical representations such as formulae, numbers, tables, graphs, charts, diagrams, symbolic equations, and the like. On the other hand, pictorial representations such as pictures, drawings, photos, and illustrations are often considered decorations or a part of the visual design of a textbook. To provide a more systematic understanding of non-textual elements in mathematics textbooks, Kim (2009, 2012) has developed a conceptual framework, each conceptual component of which is based on various studies on mathematics education, semiotics, metaphor theory, visual rhetoric, and information design. In this conceptual framework, the important aspects that constitute the quality of non-textual elements in mathematics textbooks are identified as accuracy, connectivity, contextuality, conciseness, and aesthetics. Accuracy refers to the mathematical clarity and precision of non-textual elements according to the definition of a mathematical concept. Connectivity signifies how closely the non-textual elements are related to the mathematical content contained in the texts. Contextuality indicates the presentation of mathematical expressions in a realistic context. Conciseness means

mathematical simplicity in a non-textual element. Aesthetics implies the visual appeal of non-textual elements to facilitate and motivate learning.

In addition, seven functions of explicative illustrations distinguished by Duchastel and Waller (1979) are stated as descriptive, expressive, constructional, functional, logico-mathematical, algorithmic, and data-display. Descriptive denotes the function of a visual element to provide information about what a described object actually looks like. Expressive refers to a function that aims to make an impact on the learner beyond simple explanation. Constructional indicates the function of describing how the various components of an object fit together to form the whole. Functional represents the function that aims the learner to understand how a process or system works. Logico-mathematical is a function of displaying diagrams, figures, drawings, and graphs used to explain mathematical relationships. Algorithmic illustrates the function that provides a holistic picture of the various possibilities for an action plan. Data-display refers to the function that provides a quick visual comparison and easy access to data.

Moreover, Carney and Levin (2002) underline that pictures fulfill five traditional functions in text processing: decorative, representational, organizational, interpretive, and transformational. Decorative pictures simply decorate the page with little or no relation to the text content. Representative pictures reflect some or all of the text content and are decisively the most widely used type of illustration. Organizational pictures show qualitative relationships between different elements, allowing a useful structural framework for text content. Interpretive pictures help clarify difficult texts by providing the function of interpretation and reflection thanks to their explanatory aspect. Transformative pictures contain systematic mnemonic (memory-enhancing) components designed to enhance the reader's recall by re-encoding text information to make it more tangible and then relating it through a meaningful, interactive illustration. Similarly, Elia and Philippou (2004) propose four functions (categories) of pictures in mathematical problem-solving: decorative, representational, organizational, and informational. Decorative pictures do not provide any significant information about the solution to the problem. Representative pictures illustrate all or part of the problem's content. Organizational pictures specify guidelines for drawing or written work that support the solution procedure. Finally, informative pictures provide the information necessary to solve the problem; in other words, the solution to the problem cannot be done without the picture.

It can be seen that there are both similarities and differences between the functions of non-textual elements identified by different researchers (Carney & Levin, 2002; Duchastel & Waller, 1979; Elia & Philippou, 2004; Kim, 2009, 2012). For example, the functions of pictorial illustrations by Duchastel and Waller (1979) and Carney and Levin (2002) are useful in identifying the role of non-textual elements in textbooks, especially in reading and science textbooks. Therefore, they may not be sufficient to understand the functions of non-textual elements in mathematics textbooks. In contrast to the typical non-textual elements in science, non-textual elements in mathematics are used not only as informational tools, but also as tools for reasoning, argumentation, and reflection (Cuoco & Curcio, 2001). Based on this argument, Kim (2009, 2012) discussed the functions of non-textual elements in mathematics textbooks under the headings of accuracy, connectivity, contextuality, conciseness, and aesthetics. Although there are partial differences between all these functions of non-textual elements mentioned by these researchers, it can be said that functions such as aesthetic and decorative, descriptive, expressive, informative and interpretive, as well as logico-mathematical and connectivity have many aspects that support and complement each other. Moreover, it is found that some functions of non-textual elements such as decorative, representational, and organizational functions

are underlined by both Carney and Levin (2002) and Elia and Philippou (2004). Accordingly, the conceptual framework of the study addresses all these highlighted similarities and differences in the functions of non-textual elements together. Despite the significance of non-textual elements in mathematics education, their function in the curriculum is still unclear to many teachers, especially pre-service teachers. Thus, the purpose of this article is to examine how prospective teachers identify the role of non-textual elements in a mathematics textbook. More clearly, it seeks to explore how pre-service elementary mathematics teachers interpret the functions of non-textual elements from the algebra learning domain in an eighth-grade mathematics textbook.

METHOD

Research Design

Qualitative studies are preferred in the research process, using unique methods to comprehensively and in detail capture the phenomena under investigation (Creswell, 2017). An exploratory case study, which is one of the qualitative research designs, deeply probes how individuals see themselves based on their experiences, perceptions, and feelings depending on the context, and the reasons behind them (Yin, 2014). Accordingly, this research study lends itself well to the use of a qualitative exploratory case study that focuses on pre-service teachers' interpretation of the non-textual elements in mathematics textbooks for their intended use.

Participants

The study was conducted with a total of thirty-one pre-service elementary mathematics teachers (twenty females and eleven males) enrolled in the third-year mathematics course "Analysis of Mathematics Textbooks" at a public university in Turkey. This course is designed to provide students with an overview of the pedagogical, structural, and organizational components of mathematics textbooks including didactic and graphic visual design features, language standards, contribution to meaningful learning, ease of use in the classroom, suitability for student-level, consistency with study objectives, etc. The participants of the study also volunteered based on the convenience sampling technique of the purposive (or purposeful) sampling method in qualitative research (Patton, 2014).

Data Collection

Data were collected through a task-based written questionnaire developed by the researchers and administered to the pre-service teachers as an individual assignment to be completed outside of the classroom. Evaluation done in this way not only gave the researchers flexibility in terms of time but also provided more systematic and comparable data from the participants. This questionnaire includes seven non-textual elements related to the learning outcomes in the algebra content area of the eighth-grade mathematics textbook (Middle School and Imam hatip Middle School 8 Textbook by Böge and Akıllı (2019)) published by the Ministry of National Education in Turkey. Pre-service teachers were required to interpret the functions of twenty-three non-textual elements from the algebra content area of this textbook. Among these elements, seven non-textual elements with various functions were selected to be appropriate for the study. Another point considered in selecting these seven non-textual elements is that they serve different outcomes of the algebra learning area in the mathematics curriculum. Accordingly, one non-textual element for the learning outcome "Perform multiplication of algebraic expressions" (Ministry of National Education [MoE], 2018), and two non-textual elements for each of the learning outcomes "Explain identities with models" (MoE, 2018), "Solve first-degree inequalities in one variable" (MoE, 2018), and "Explain the slope of a line using models, relate linear

equations and their graphs to slope" (MoE, 2018) were selected for investigation (see in Appendix 1). Participants were asked to write down their thoughts about the usefulness of these non-textual elements compared to symbols and textual information, what kind of roles or functions they have in learning and teaching mathematics, and in which aspects they are more remarkable. Prior to data collection, a task-based questionnaire was also piloted with four students not involved in the actual study to assess the extent to which the questionnaire could elicit responses to address the research question. Expert opinions were also taken into consideration. Based on the feedback received, necessary amendments were made to arrive at the final version of the task-based written questionnaire. In this respect, two questions were removed from the task-based questionnaire, which initially consisted of five questions. One of them was excluded from the questionnaire because it was a general statement covering other questions. The other one was excluded because it was thought that pre-service teachers did not have sufficient expertise in textual and visual literacy about the lack of features that non-textual elements should have. Therefore, it was not evaluated within the scope of this study.

Data Analysis

Data analysis was performed using the content analysis method, which requires an in-depth analysis of the collected data and allows to uncover of previously unspecified themes and dimensions (Corbin & Strauss, 2015). All participants were coded from P1 to P31 to protect their confidentiality. Their responses to the task-based questionnaire were received in writing. Qualitative data analysis software NVivo (QSR International, 2012) was also used to assist in coding and categorizing data to identify common themes and patterns. Using this software allowed us to eliminate potential conflicts in the interpretation of data and ensure the accuracy of the research work by comparing it to the participants' responses. Taking into account both the relevant literature (Carney & Levin, 2002; Duchastel and Waller, 1979; Elia & Philippou, 2004; Kim, 2009, 2012) and the data itself, an initial list of codes was developed by assigning a code to each piece of information received from pre-service teachers. For example, the preliminary code list for pre-service teachers' interpretations of the image of the fourth problem (see Figure 4 in Appendix 1), in which the algebraic identity $a^2 - b^2 = (a-b)(a+b)$ is shown by the area models, was created as attention, clarifying, embodying, explanatory, facilitating, helping solution, informative, instructive, interpretative, logical, modeling, rational, representative, simple, supportive, understandable, and useful. After the coding phase was completed, similar codes were grouped into categories, which were further merged to form main themes. For instance, codes such as embodying, modeling, and representative were included under the theme of embodiment while codes such as facilitating, helping solutions, supportive, understandable and useful were placed under the theme of organizing. Similarly, codes such as clarifying, informative, and instructive were classified into the theme of informativeness while codes such as interpretative, logical, and rational were grouped into the theme of reasoning. After the creation of themes identifying the functions of the non-textual elements was completed, their frequencies were also calculated. Participants' responses were evaluated separately for each theme created, and the ones that best reflected everyone's views were quoted directly. Since credibility and transferability were important to ensure the validity of the research, direct quotations with the views of the participants were often included while presenting the findings, and the results were interpreted based on those views. Through member checks, respondents were also asked to clarify or disagree with something in the transcripts to identify and minimize potential bias. The aim was therefore to disclose the research results accurately and impartially so that the emerging themes could form a

coherent and meaningful whole as much as possible (Merriam & Tisdell, 2016). Moreover, to facilitate inter-coder reliability (Miles & Huberman, 1994), a mathematics education researcher was asked to act as an external rater. Accordingly, in the last step of the analysis, in addition to the expert review, this mathematics education researcher and the authors double-checked the codes in all transcripts and reexamined the resulting categories. The comparison of the two codings resulted in an overall agreement of 88 percent across all categories. The raters resolved any disagreements and revised the codes until full agreement was reached for the categories to ensure the confirmability and dependability of the data collected.

Ethical Principles

Ethics committee permission for this study was obtained from Zonguldak Bülent Ecevit University Human Research Ethics Committee with the decision dated 05.10.2022 and numbered 221989/326.

FINDINGS

A cross-case analysis of the data from thirty-one pre-service teachers revealed ten themes that captured their views on the functions of seven images selected from the eighth-grade mathematics textbook in the algebra content area focusing on algebraic expressions and identities, linear equations, and inequalities: *(i) attractiveness, (ii) organizing, (iii) embodiment, (iv) informativeness, (v) reasoning, (vi) conciseness, (vii) essentiality, (viii) decorativeness, (ix) contextuality, and (x) connectivity.* Pre-service teachers' views on the functions of the non-textual elements were thematized and the frequencies of each theme are given in Table 1. The following sections provide the findings concerning these emergent themes.

Table 1

Frequencies and functions attributed by pre-service teachers to non-textual elements

Functions	Number of Participants						
	(Non-textual Element-1)	*(Non-textual Element-2)*	*(Non-textual Element-3)*	*(Non-textual Element-4)*	*(Non-textual Element-5)*	*(Non-textual Element-6)*	*(Non-textual Element-7)*
Attractiveness	22 (71%)	20 (65%)	21 (68%)	20 (65%)	9 (29%)	18 (58%)	8 (26%)
Organizing	9 (29%)	21 (68%)	23 (74%)	22 (71%)	14 (45%)	27 (87%)	15 (48%)
Embodiment	17 (55%)	17 (55%)	20 (65%)	22 (71%)	8 (26%)	22 (71%)	12 (39%)
Informativeness	0 (0%)	8 (26%)	10 (32%)	8 (26%)	6 (19%)	19 (61%)	7 (23%)
Reasoning	4 (13%)	1 (3%)	3 (10%)	6 (19%)	8 (26%)	8 (26%)	1 (3%)
Conciseness	0 (0%)	0 (0%)	9 (29%)	5 (16%)	2 (6%)	0 (0%)	3 (10%)
Essentiality	0 (0%)	11 (35%)	1 (3%)	0 (0%)	9 (29%)	12 (39%)	8 (26%)
Decorativeness	21 (68%)	1 (3%)	0 (0%)	0 (0%)	1 (3%)	2 (6%)	0 (0%)
Contextuality	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Connectivity	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	0 (0%)

Attractiveness

Most of the pre-service teachers in this study mentioned the attractiveness of non-textual elements. For example, twenty-two participants indicated that the image of the first problem about daily life (see

Figure 1 in Appendix 1), which requires writing a mathematical expression with first-degree inequalities in one variable, can draw students' attention to the problem. One of the pre-service teachers put it as follows:

… with the picture given in a text, it was aimed to draw students' attention to the problem by enabling them to visualize the problem situation in their minds (P13).

Similarly, twenty-one participants stated that the image belonging to the third problem (see Figure 3 in Appendix 1), where the multiplication of algebraic expressions is illustrated using area models, has the function of attractiveness and that it can arouse students' curiosity and positively affect the attempts to solve the problem. As one of the participants expressed:

... I think that it is a visual that will stimulate the curiosity and attention of the students and will capture their interest in solving the problem (P27).

In addition, twenty participants pointed out that the attractive function of the image in the second problem (see Figure 2 in Appendix 1), dealing with transforming the real-life problem into a mathematical statement, can increase students' motivation to solve the problem. As stated by one of the participants:

…This picture has a role in raising the motivation of students...The fact that the visual is colorful and the tools used in real life may attract students' attention (P9).

Organizing

Organizing is a function emphasized by most of the pre-service teachers in all non-textual elements. For instance, twenty-seven participants referred to the organizing function of the image in the sixth problem (see Figure 6 in Appendix 1), where the slope is explained with models from everyday life. They mentioned that this image supports textual information and makes it useful for solving the problem. One of the participants expressed this as follows:

…I think textual information about the problem is supported by this picture and it is quite useful for solving the problem. … It is a visual that helps students understand the problem and therefore reinforces the topic being covered (P28).

Twenty-two participants also considered the purpose of using the image belonging to the fourth problem (see Figure 4 in Appendix 1), in which identities are explained with area models, as organizing because the image facilitates the solution of the given problem by organizing given information logically and coherently to produce mathematical ideas. As stated by one pre-service teacher:

…this image organizes information given in the problem and facilitates its solution in a way that encourages students to form their own ideas (P10).

Similarly, twenty-one participants mentioned the organizing function of the image used for the second problem (see Figure 2 in Appendix 1), which is about expressing the real-life problem of inequalities mathematically, as it provides students with information about the problem and helps them plan its solution. As one of the participants remarked:

… equal arm weighing scales in the figure are used to inform students, support their understanding, and facilitate the planning of the solution for the problem (P15).

Embodiment

Embodiment is also a function revealed by most of the pre-service teachers in all non-textual elements. For example, twenty-two participants expressed their thoughts about the role of the image of the fourth problem (see Figure 4 in Appendix 1), in which identities are illustrated with area models. Pre-

service teachers mentioned that the given image allows students to discover the algebraic identity $a^2-b^2=(a-b)(a+b)$ by embodying the learning process. They stated that mathematical principles that are difficult to visualize in a way that makes sense in the mind are embodied using visual representations or images. That is:

…thanks to this visual, the identity $a^2-b^2=(a-b)(a+b)$, which is an abstract fact for students, is modeled using areas, and thus it is proved by embodied (P24).

Likewise, twenty participants argued that the image belonging to the third problem (see Figure 3 in Appendix 1), which is about performing multiplication with algebraic expressions with area models, embodies the given problem and makes its solution understandable. As stated by one of the participants:

…the geometric shapes in the picture are visual elements used to make algebraic expressions meaningful. Explaining this subject only with algebraic expressions remains abstract for students, but the shapes used to represent the problem embody its solution for students (P13).

Also, twelve participants explained that the image of the seventh problem (see Figure 7 in Appendix 1), discovering the slopes of parallel and perpendicular lines, embodies abstract concepts in the problem that are difficult for students to understand. One of the participants put it simply:

…If only textual information is included, the problem may be difficult to understand and the problem may remain abstract. The inclusion of the image embodies the solution in the mind (P23).

Informativeness

Informativeness is another function that is noted by the pre-service teachers in all images except the image of the first problem. For example, nineteen participants mentioned the informative function of the image on the sixth problem (see Figure 6 in Appendix 1), illustrating that the slope is the ratio of vertical length to horizontal length in a model related to daily life. As pointed out by one participant:

…The three shapes with different slopes given in the image make it easier for students to understand that as the height increases, the slope will increase and as the length increases, it will decrease. For this reason, the images provided are informative to understand the subject and contribute to learning (P17).

Eight participants also supported that the image (see Figure 4 in Appendix 1), in which the algebraic identity $a^2-b^2=(a-b)(a+b)$ is proved by the area models, has an informative function as it makes the learning more effective and permanent by explaining the relationships between concepts. One of the pre-service teachers expressed that:

…demonstrating the identity with an area model instead of just showing it as a long mathematical expression makes learning more permanent. Even if students forget the algebraic identity, they can remember this model and prove it themselves (P5).

Similarly, seven participants emphasized the informative function of the image belonging to the seventh problem (see Figure 7 in Appendix 1), examining the relationship between parallel and perpendicular lines and the concept of slope. As one participant stressed:

…this visual is used to explain the relationship between the slopes of two lines that are parallel or perpendicular… In place of writing a long mathematical text, it is used to summarize the text and highlight the important information students need to know (P10).

Reasoning

The other function of the non-textual elements stated by the pre-service teachers is reasoning. For example, eight participants expressed that allowing the comparison of the slopes given in the figure on the sixth problem (see Figure 6 in Appendix 1) contributes to the interpretation of factors affecting the magnitude of the slope, thus revealing the reasoning function. As put by one of the participants:

…thanks to the shapes in the given figure, it can be easily interpreted in which cases the slope increases and in which cases it decreases (P12).

Similarly, six participants mentioned that the image of the fourth problem (see Figure 4 in Appendix 1), in which the algebraic identity $a^2-b^2=(a-b)(a+b)$ is shown by the area models, allows the interpretation of the problem situation and reasoning by thinking deeply about the problem situation. In other words, they stated that the visual can encourage students to think mathematically, as it helps to see how the given problem can be solved. In the words of a pre-service teacher:

…instead of memorizing the given identity, the students try to think and interpret the reason for it with the help of the given visual...if only textual information is included, it will be more abstract and difficult to explain and interpret the identity (P28).

Conciseness

Conciseness is another function underlined by the pre-service teachers in all non-textual elements except the first, second, and sixth non-textual elements. For instance, nine participants stated that the image presented in the third problem (see Figure 3 in Appendix 1) about performing the multiplication of algebraic expressions can simply and concisely convey the meaning of the multiplication operation on algebraic expressions by modeling the equation $x(2x+1)=2x^2+x$ using areas. As one of the participants noted:

…I think it is very helpful compared to textual information because what is meant to be explained in the text is modeled with a given visual more simply and understandably (P26).

In a like manner, three participants stated that the image of the seventh problem (see Figure 7 in Appendix 1), aiming to relate the concept of slope to parallel and perpendicular lines, shows the relationship between these concepts clearly. As posited by one of the participants:

…It is a useful visual as it clearly shows what is meant to be given in the problem (P11).

Essentiality

Essentiality was indicated as another function of non-textual elements in all visuals except the first and fourth ones. For example, eleven participants pointed to the essentiality function by stating that the mathematical expression required in the problem could not be written without the image given in the second problem (see Figure 2 in Appendix 1), focusing on expressing mathematical statements of real-life problems related to inequalities. As remarked by one of the participants:

…the visual is necessary for solving the problem. Otherwise, the text describing the question is useless without the image provided (P4).

Similarly, nine participants stated that the image of the fifth problem (see Figure 5 in Appendix 1), in which the algebraic identity $(a+b)^2=a^2+2ab+b^2$ is shown, is essential for understanding the related problem. In other words,

…the given visual is part of the problem and is necessary for the solution of the problem (P1).

Decorativeness

Most of the pre-service teachers emphasized the decorative function of the given non-textual elements. For instance, twenty-one participants pointed to the decorativeness of the visual given with the first problem (see Figure 1 in Appendix 1), which is about writing a mathematical expression suitable for daily life situations involving first-order inequalities with one unknown. They also commented on whether the given problem can be solved without its visuals. One of the participants put it as follows:

…this visual does not contain any information about the solution to the problem, it is only used for decorative purposes. Even if the visual is not used here, this problem can be solved (P10).

Contextuality

Contextuality was highlighted by one pre-service teacher in the image of the second problem (see Figure 2 in Appendix 1), which requires transforming a real-life problem based on inequalities into mathematical expressions. It was assumed that with this image, students can establish a relationship between everyday life and mathematics. As stated by one of the pre-service teachers:

…given a weighing instrument used in everyday life, this visual helps students to relate the subject of inequality to daily life (P3).

Connectivity

Connectivity emerged as another function of non-textual elements, which was pointed out by only one participant in the image of the fifth problem (see Figure 5 in Appendix 1), where the algebraic identity $(a+b)^2 = a^2 + 2ab + b^2$ is proved. A pre-service teacher asserted that since the given image is related to the content of the problem there is a connectivity function.

…I think that the visual chosen in connection with the textual information of the problem helps students embody what is described in the text and visualize the problem in their minds (P1).

DISCUSSIONS AND CONCLUSIONS

In this study, pre-service elementary mathematics teachers emphasized various functions of seven non-textual elements that are part of algebra learning outcomes in an eighth-grade mathematics textbook. In this regard, ten different functions were identified in total: *(i) attractiveness, (ii) organizing, (iii) embodiment, (iv) informativeness, (v) reasoning, (vi) conciseness, (vii) essentiality, (viii) decorativeness, (ix) contextuality, and (x) connectivity*. It was seen that pre-service teachers attributed at least five different functions to each of the non-textual elements (see Table 1). Therefore, as stated in the literature, it has been shown that non-textual elements can have more than one function, or more than one meaning can be attributed to a non-textual element (Carney & Levin, 2002; Elia & Philippou, 2004; Kim, 2009, 2012; Lee & Ligocki, 2020).

It has often been emphasized that each non-textual element used in this study has the functions of attractiveness, organizing, and embodiment. Similarly, some studies asserted that most of the pictures used in mathematics textbooks were attractive because pictures did contribute to the attractiveness of the learning material and the enjoyment of reading (Biron, 2006; Peeck, 1993). Besides, in the studies analyzing the functions of the pictures in the problem-solving process (Elia & Philippou, 2004), the roles of pictorial illustrations in mathematics textbooks (Carney & Levin, 2002), and the way prospective teachers interpret and use non-textual elements in mathematics curriculum materials (Lee & Ligocki, 2020), visuals were found to organize the problem-solving process. In addition, visualization

is essential for mathematical generalization and abstraction because visual representations can embody a concept in various ways and make it comprehensible (Demircioğlu & Polat, 2015; Dufour-Janvier, Bednarz & Belanger, 1987; Yilmaz & Argun, 2018). Therefore, it can be argued that these three functions of visuals (attractiveness, organizing, and embodiment) will have a critical role in the effective internalization of the abstract content of algebra in mathematics textbooks.

Another important finding is that reasoning, which pre-service teachers believe plays a crucial role in the implementation of all mathematical skills, is a function expressed in all non-textual elements used in the study. It has long been known that using certain types of representations (visual, concrete, etc.) allows students to develop mathematical skills such as reasoning and helps them acquire advanced problem-solving skills (Presmeg, 2020). Therefore, considering the fact that non-textual elements used in teaching mathematics facilitate students' reasoning processes (Alsina & Nelseni, 2006), it is important to include such non-textual elements in the algebra content area of mathematics textbooks.

It was also found that pre-service teachers attributed an informative function to six non-textual elements and an essentiality function to five non-textual elements in the study. Seffah (2017) indicated that in most textbooks, visual representations, which are an important tool that can contribute to a comprehensive understanding of the concept of the series, are rarely used, and they have the function of essentiality as in this study. Karakaya (2011) noted that most of the visual representations of functions used in mathematics textbooks have an informative function. Therefore, it is important for the teaching of algebraic concepts that the non-textual elements in the textbooks have informative and essentiality functions, as they initiate mathematical thinking by explaining the text and providing the necessary information for solving the problem.

Moreover, conciseness, interpreted as mathematical simplicity by pre-service teachers, was a function that emerged in the four non-textual elements used in the study. Pettersson (2001) contended that too much detail or complexity reduces interest in visual content, while too little detail or complexity makes it impossible to understand the picture. In other words, since mathematics is such a precise subject, the ambiguity of complex visual representations can prevent students' understanding of the concept (Goldin & Shteingold, 2001). Simple or concise non-textual elements facilitate understanding of the mathematical concept and making connections between the concept and other related mathematical concepts (Kim, 2012). Because concise non-textual elements can clearly and effectively convey the meaning and idea when teaching a new concept, such elements can also help students better understand algebraic concepts.

Another function expressed in four non-textual elements is decorativeness, referred to as the aesthetics or visual appeal of the images. Sinclair (2006) argued that aesthetics should be considered an important step for success in mathematics because it is closely related to students' understanding and learning styles of mathematics. Goldin (2000) emphasized that aesthetics is important not only to help students discover beauty in mathematics, but also because it affects students' affective characteristics such as emotions, beliefs, and attitudes toward mathematics. In this respect, one can better understand that the decorative function of the visuals in the textbooks is more valuable for teaching algebra.

On the other hand, contextuality, mentioned as the representation of mathematical expressions in a realistic context, was a function emphasized by the pre-service teacher only in one non-textual element. Wiggins (1993) asserted that it is inappropriate to evaluate information out of its context. Ferratti and Okolo (1996) showed that students' thinking skills and attitudes improve as they solve problems in realistic contexts. Non-textual elements with a contextual function can facilitate students'

understanding and learning through connections between mathematics and real life (Kim, 2012). Therefore, it should be kept in mind that such non-textual elements in textbooks can enable students to understand and deepen algebraic concepts by encouraging them to think in their own context. In addition, connectivity, interpreted by the pre-service teacher as the non-textual elements being closely related to the mathematical content in the texts, was a function specified only in one non-textual element, as in the contextuality function. Since visual representations can serve as models or problem-solving tools to show students what they cannot see in texts and symbols (Arcavi, 2003), it is important to establish close connections between mathematical texts and visual representations in teaching algebra. Because textual literacy may not be at the same level as visual literacy for every student, students who have difficulty reading and comprehending mathematical texts can learn more and understand better through visuals (Kim, 2012). Therefore, visual representations can provide some students with opportunities to learn mathematics that they cannot understand only from algebraic textual expressions.

Overall, this study provides an overview of pre-service elementary mathematics teachers' interpretations of the functions of non-textual elements from the content area of algebra in a mathematics textbook. Pre-service teachers were found to have diverse but sometimes overlapping interpretations of the functions of each non-textual element. However, the functional diversity of non-textual elements may have challenged their interpretations, as visual processing skills and strategies are required to interpret the intended use of non-textual elements. Some pre-service teachers had difficulty seeing the connections between the information in the pictures and the mathematical texts containing algebraic expressions. Understanding the intended message of the non-textual elements in mathematics textbooks seems to be something that some prospective teachers are unlikely to do unless they have carefully planned, intentional training on the matter. Otherwise, despite increasing informational texts and visual content in textbooks, these prospective teachers will hardly be able to teach their students to read visual elements as well (Metros, 2008). Therefore, in order to enhance pre-service teachers' understanding of the functions of non-textual elements, not only should researchers develop various instructional approaches that promote pre-service teachers' visual literacy, but these instructional approaches to visual literacy should also be incorporated into teacher education and professional development. Moreover, while our study will guide future research by documenting the functions of non-textual elements encountered in an algebra content area of a mathematics textbook, it would be valuable to extend this work to other possible functions of non-textual elements by considering different learning domains and various mathematics textbooks.

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APPENDIX

Appendix 1. Non-textual elements given in the task-based written questionnaire

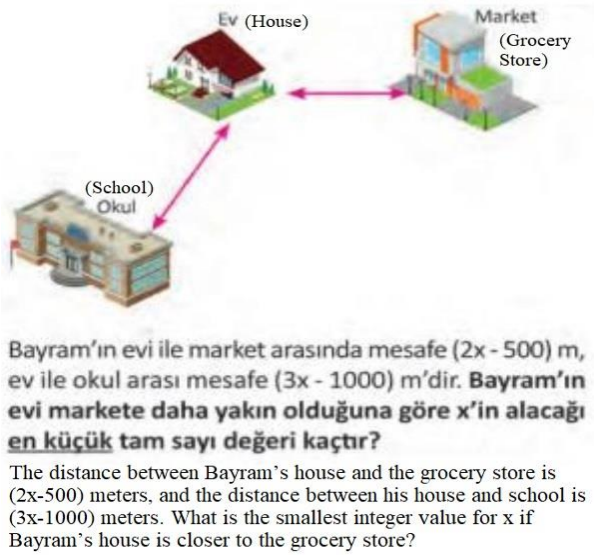


Figure 1. Non-textual element of the learning outcome "*Solve first-degree inequalities in one variable*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 143) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 143)].

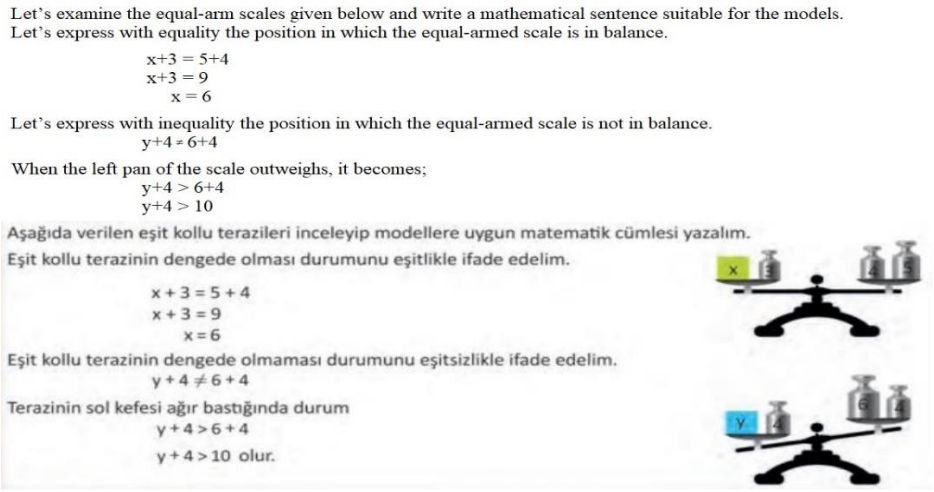


Figure 2. Non-textual element of the learning outcome "*Solve first-degree inequalities in one variable*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 134) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 134)].

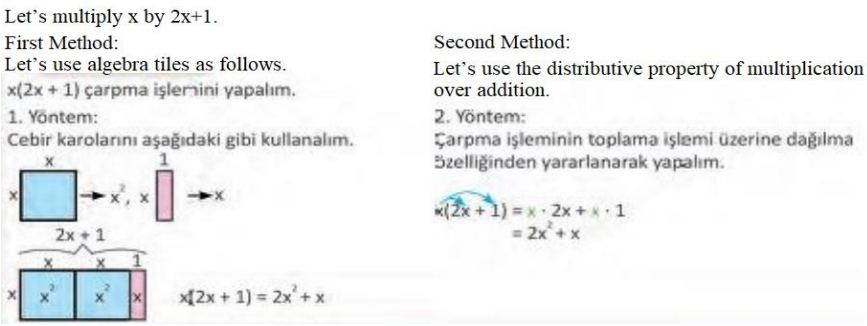


Figure 3. An example of the learning outcome "*Perform multiplication of algebraic expressions*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 92) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 92)].

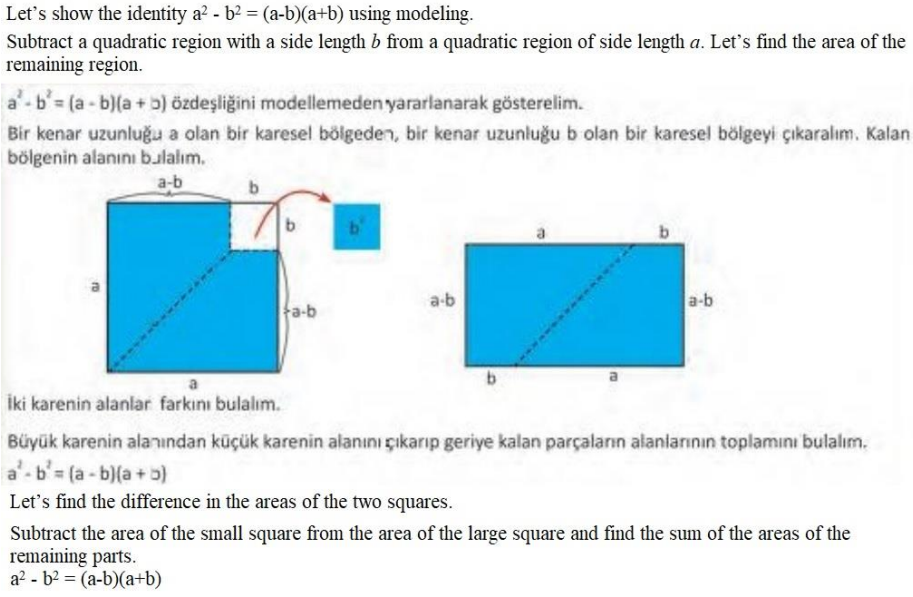
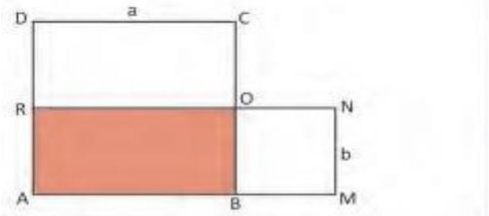


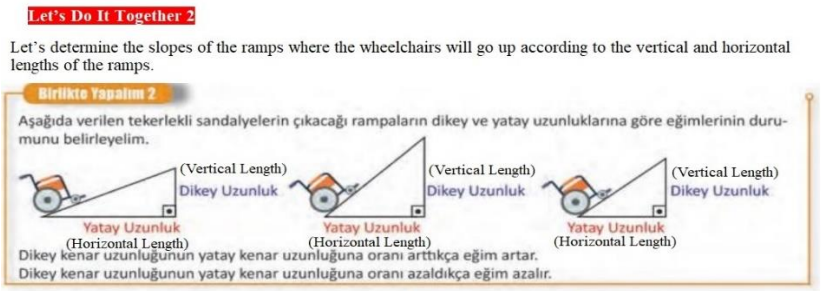
Figure 4. Non-textual element of the learning outcome "*Explain identities with models*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 99) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 99)].



Yukarıdaki şekilde ABCD ve BMNO birer karedir. Bu iki karenin alanları toplamı 96 br² ve a + b = 14 br'dir. R, O, N doğrusal noktalar olduğuna göre ABOR dikdörtgeninin alanı aşağıdakilerden hangisidir?

In the figure above, ABCD and BMNO are squares. The sum of the areas of these two squares is 96 square units and a+b=14 units. If R, O, N are linear points, which of the following is the area of the rectangle ABOR?

Figure 5. Non-textual element of the learning outcome "*Explain identities with models*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 108) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 108)].



As the ratio of the vertical side length to the horizontal side length increases, the slope increases.
As the ratio of the vertical side length to the horizontal side length decreases, the slope decreases.

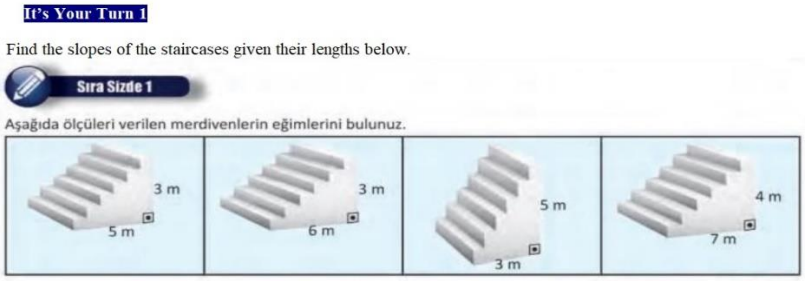


Figure 6. Non-textual element of the learning outcome "*Explain the slope of a line using models, relate linear equations and their graphs to slope*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 131) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 131)].

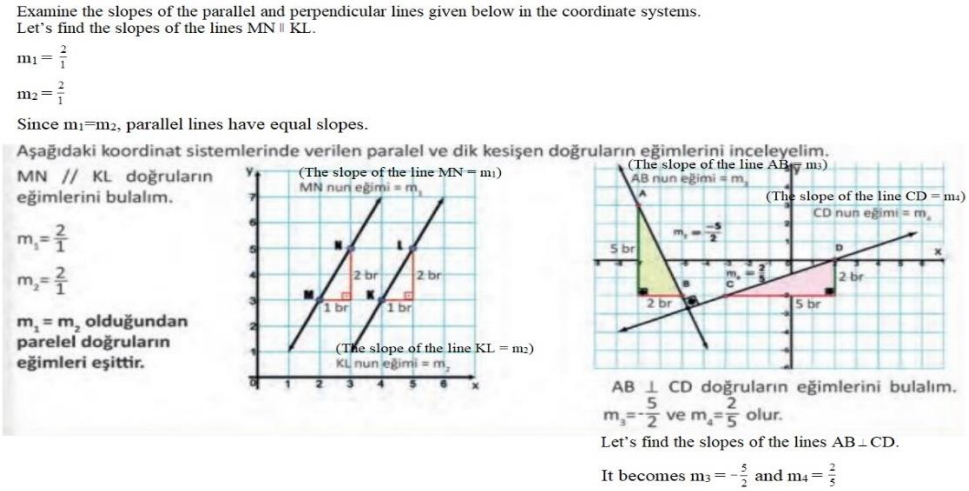


Figure 7. Non-textual element of the learning outcome "*Explain the slope of a line using models, relate linear equations and their graphs to slope*" (MoE, 2018). Source: Middle school and imamhatip middle school 8th-grade mathematics textbook (Böge & Akıllı, 2019, p. 133) [Ortaokul ve imamhatip ortaokulu matematik 8 ders kitabı (Böge & Akıllı, 2019, ss. 133)].

Author Contributions

The authors contributed equally for writing the article, conceptualization of the article, data collection, analysis and discussion.

Conflict of Interest

No potential conflict of interest was declared by the author.

Supporting Individuals or Organizations

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Ethical Approval and Participant Consent

Ethics committee permission for this study was obtained from Zonguldak Bülent Ecevit University Human Research Ethics Committee with the decision dated 05.10.2022 and numbered 221989/326.

Plagiarism Statement

Similarity rates of this article was scanned by the iThenticate software. No plagiarism detected.

Availability of Data and Materials

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The Adaptation Study of The Student Engagement in the General Chemistry Laboratory Scale to Turkish

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Abstract

Chemistry laboratories are an essential and indispensable part of chemistry education; however, the process in the laboratory cannot fully provide the desired gains. Although various scales in the literature address the process in the chemistry laboratory from different perspectives and enable evaluations, a new perspective on the process is student engagement. By determining to what extent and how students engage in the process, the chemistry laboratory can be carried out more effectively, and the efficiency of the teaching process can be increased by making the necessary arrangements. This study aimed to adapt the scale (Smith and Alonso, 2020) from international literature to Turkish and to determine its validity and reliability. For this purpose, the original scale went through the translation phase, and its language validity was checked. The sample of this study consists of 242 students who continue their education in Sakarya University (N= 158) and Gazi University (N=84) Education faculties, Science teaching and Classroom teaching departments. Then its construct validity was ensured by Confirmatory Factor Analysis. Its reliability was studied by determining the internal consistency coefficient. At the same time, the comparison of the data according to some demographic characteristics was also carried out. As a result, The Student Engagement in The General Chemistry Laboratory Scale adapted to our language is a valid and reliable scale consisting of 25 items and six factors.

Keywords

Chemistry Lab, Scale, Student Engagement.

Ethics Committee Approval: Ethics committee permission for this study was obtained from Sakarya University Ethics Committee with the decision dated 10.11.2021 and numbered 01/10.

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INTRODUCTION

Chemistry laboratories are considered by many researchers (Hofstein & Lunetta, 1982; 2004; Galloway & Bretz, 2015a, 2015b; Bretz, 2019; Reid & Shah, 2007) as an important and integral part of chemistry education. Considering that students often have difficulties in understanding the content of chemistry courses and students have many misconceptions (Canpolat et al., 2004; Johnstone, 1991; Taber, 2001; Sirhan, 2007), the importance and function of chemistry laboratories can be better understood. The functions of laboratories in the teaching process are mostly linked to providing students with a scientific perspective, contributing to the understanding of the theory in practice, helping to learn laboratory techniques, love science and create motivation for a scientific career, helping to develop practical skills, and also contributing the development of skills such as group work and cooperation. (Hofstein & Lunetta, 1982; 2004; Bretz, 2019; Reid & Shah, 2007). However, especially in our country, the use of laboratories in teaching is still limited due to the lack of knowledge and experience of teachers, the lack of materials in the laboratory, the cost of the process, and the dangerous situations that may occur during the process (Özgür, Odabaşı, & Erdoğan, 2017; Güneş et al., 2013; Nakiboğlu and Sarikaya, 2000). In addition, it is frequently mentioned in the literature (Hofstein & Lunetta, 2004) that the desired gains are still not achieved at the end of the laboratory process, and it is expected to design processes aiming to achieve better gains. At this point, the importance of examining the process in the laboratory emerges. In order for the process in the laboratory to reach the desired gains, meaningful learning must take place. Ausubel (1968) states that for meaningful learning to occur, the student should have prior knowledge, present the new material in a meaningful way, and be able to establish relationships between the new material and their prior knowledge. Galloway and Bretz (2015a) developed the Meaningful Learning Scale in the Laboratory based on the theory of meaningful learning to evaluate the process in the laboratory. This measurement tool consists of a total of 31 cognitive and affective (expectation and experience) items. Researchers state that it is possible to compare the pre-experimental and post-experimental experiences of the students in various experiments by using this measurement tool, and that necessary arrangements can be made, and they draw attention to the importance of the affective dimension for meaningful learning to occur. The same researchers (Galloway & Bretz, 2015b) used this measurement tool and conducted in 15 universities and colleges (N=3583) in the United States and found that students' expectations before the experiment shape the experiences and that cognitive expectations are necessary for meaningful learning. However, they stated that it is not enough on its own.

One of the important studies in the literature on the affective dimension of the process in the chemistry laboratory belongs to Bowen (1999). The researcher has developed a measurement tool (Chemistry Laboratory Worry Scale) that aims to measure the concerns of students, which constitute an obstacle to achieving the desired gains in the process in the chemistry laboratory. This scale, which was later adapted into Turkish by Azizoğlu and Uzuntiryaki (2006), can make it possible to determine the concerns of the students in the laboratory process and to redesign/modify the process considering these concerns.

Another factor in not being able to achieve the expected gains from the chemistry laboratory may be that the expectations of the students and instructors, who are the components of the process, from the process do not fully overlap with each other. As a result of the study conducted by Bruck, Towns, and Bretz (2010) on the expectations of faculty members from the chemistry laboratory, although it is different for various laboratory courses (such as general chemistry laboratory, organic chemistry laboratory, research laboratory); it is stated that teaching laboratory techniques and skills, teaching

critical thinking skills and experimental design, integrating scientific explanations about the course into the laboratory, providing scientific thinking and group work, and developing written communication skills are common expectations. In a study by DeKorver and Towns (2015), students' expectations from the chemistry laboratory were investigated, and as a result, it was found that expectations such as "finishing the experiment early" and "getting a good score" were at the forefront. Therefore, it is seen that the students, who are the components of the process, have more affective expectations, while the instructors have more cognitive expectations and they do not overlap with each other much.

All these studies, which examine the process in the chemistry laboratory from different perspectives, assume full engagement of the students in the process. According to Fredricks, Blumenfeld, and Paris (2004), school engagement can be expressed in three dimensions as behavioral, affective and cognitive engagement. Behavioral engagement can be defined as the student's involvement in academic tasks and activities and can be understood with the effort, persistence and patience of the student. Affective engagement is the student's affective reactions in the academic environment and can be understood by indicators such as curiosity, interest, boredom, and anxiety. Cognitive engagement, on the other hand, refers to the psychological and physiological participation and involvement of students in academic tasks and can be understood with indicators of learning, understanding, and specialization. For example, the fact that the student attends the lesson to act with his/her friends even though he/she is not interested in the content of the lesson shows his/her behavioral engagement, or being worried about the lesson content helps to understand that lack of emotional engagement. These three dimensions of engagement can also be expressed in response to the three dimensions of meaningful learning, which are affective, cognitive, and psychomotor learning, and just as meaningful learning does not occur when the three dimensions are not together, it cannot be said that there is full engagement in the process without affective, cognitive and behavioral engagement. A study that handles the process in the chemistry laboratory from this perspective was conducted by Smith and Alonso (2020), and as a result of the study, a scale was developed to measure the engagement of students in the general chemistry laboratory. Researchers state that by using Student Engagement in the General Chemistry Laboratory scale, the process in chemistry laboratories can be examined and necessary arrangements can be made according to the data obtained. It is clear that examining the process in the chemistry laboratory and making the necessary arrangements will contribute positively to the improvement of the teaching process. Although there are various scales in the literature (Uzunoğlu & Tiryaki, 2006; Alkan & Erdem, 2012; Galloway & Bretz, 2015a; Sadler et al., 2011) in order to examine the process in the chemistry laboratory, it is useful to examine student engagement in the chemistry laboratory from a different perspective. According to our experience in chemistry laboratories and literature review, no study has been found in our country in which the process in the chemistry laboratory is discussed in this respect, and it is thought that it would be beneficial to adapt Student Engagement in the General Chemistry Laboratory Scale, which originally developed by Smith and Alonso (2020), into Turkish. Therefore, this study aims to adapt the scale to Turkish.

METHOD

Since a scale adaptation study was carried out in this study, a quantitative research method was adopted in the study.

Sample

The sample of this study consists of 242 students who continue their education in Sakarya University (N= 158) and Gazi University (N=84) Education faculties, Science teaching and Classroom teaching departments. The sample was determined according to the convenient sampling method, which is one of the non-random sampling methods. The convenient sampling method aims to reduce the loss of time, labor, and mone, and is based on the creation of tasample from people who can be easily reached by the researcher (Büyüköztürk et al., 2016). Demographic characteristics of the sample are presented in Table 1.

Table 1

Demographic Characteristics of the Sample

		f
Gender	Female	219
	Male	23
University	Sakarya University	158
	Gazi University	84
Year of education	First year	31
	Second year	83
	Third year	61
	Fourth year	67
Department	Science Teaching	209
	Classroom Teaching	33

Original scale

The scale, which was adapted into Turkish, is the "Student Engagement in the General Chemistry Laboratory Scale" developed by Smith and Alonso (2020). This original scale consists of a total of 25 items and 6 factors and is in a 4-point Likert structure. While developing the scale, students at a public university located in the north-west of the United States were chosen as the sample of the study. First, a 46-item pre-scale was prepared, which constitutes the theoretical foundations of the scale and questions emotional, behavioral, and cognitive student engagement. As a result of the statistical analysis final version of 25 items was reached. The scale consists of 6 factors as cognitive engagement in data collection and general, negative emotional engagement in laboratory procedures, positive emotional engagement in laboratory procedures, behavioral engagement in laboratory procedures, cognitive engagement in laboratory procedures and negative emotional engagement in data collection.

Research Ethics

All the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were complied with in the whole process, from the planning of this research to its implementation, from data collection to data analysis. None of the actions specified under the heading "Actions Contrary to Scientific Research and Publication Ethic,", the second part of the directive, have been taken. Scientific, ethical, and citation rules were followed in the writing process of this study; No

falsification was made on the collected data and this study was not sent to any other academic publication medium for evaluation.

Process

According to the International Test Commission (International Test Commission, 2017), cross-cultural scale adaptation studies consist of stages of: researching the scales related to the feature to be measured, developing a new scale, and comparing the advantage of adapting the existing scale in the international literature, obtaining permission from the original scale developer(s), translating the scale from the original language to the target language, converting the scale from the target language back to the original language, reviewing the translations, making an application to ensure language validity, applying to the target group, performing item analyzes and validity and reliability analyzes. In this study, these steps were carried out as described in detail below.

First, the scales related to the feature to be measured were investigated. The importance of engagement in the chemistry laboratory (cognitive, affective, and behavioral engagement) in gaining achievements in the laboratory has been demonstrated by many studies in the literature. Therefore, the existing scales in the domestic literature on "engagement in the chemistry laboratory", the subject of this study and which is stated to be important in chemistry teaching, were examined. As a result of the examination, it is found that there are some scales in the litearture like the pre-service teachers' anxiety about the chemistry laboratory (Azizoğlu & Uzuntiryaki, 2006), pre-service teachers' attitudes towards laboratory skills (Alkan & Erdem, 2012), pre-service teachers' self-efficacy perceptions towards the chemistry laboratory (Alkan, 2016) and pre-service teachers' perceptions about laboratory practices (Feyzioğlu et al., 2012). However there is no scale for engagement in the chemistry laboratory. But, it has been determined that there is a scale (Smith & Alonso, 2020) to measure this phenomenon in the international literature.

Then, it was decided that adapting this scale would be more advantageous than developing a new scale due to the existence of a valid and reliable scale in the literature regarding the subject to be researched. After that, permission was obtained by contacting the authors of the original scale via e-mail. Then, an application was made to Sakarya University Educational Research and Publication Ethics Committee and the necessary ethics committee document (dated 12.11.2021 and numbered E-61923333-050.99-79435) was obtained.

Then, the scale items were translated from the original language (English) to the target language (Turkish) by 3 different experts (Turkish academics who have given chemistry laboratory courses and who are fluent in English). Three other experts (Turkish academics who have given chemistry laboratory courses and are fluent in English and different from their predecessors) have translated these translations from Turkish to English with the back translation method. Then, the forms in both languages were examined by interviewing two people who are fluent in both languages (Turks with chemistry laboratory experience and fluent in English) and necessary arrangements were made. In order to ensure language validity, application to students who have command of both languages and have experience in the chemistry laboratory (students studying at Boğaziçi University Science Education and Chemistry Teaching programs, n=13) was made (given the scale in the original language first and then the translation scale, not simultaneous) and the correlation between the responses was calculated.

After the language validity was ensured, the translated draft scale was obtained, and the application of this draft to a suitable sample for the target group and item analysis phase was started. For this

purpose, since it was desired to reach students who have experience in the chemistry laboratory, this translated draft scale was applied to prospective teachers (n=242) who continue their educationthe in Science and Classroom Teaching programs of Sakarya University and Gazi University. With the obtained data, item analyzes and validity and reliability analyzes were started.

Data analysis

In order to investigate the language validity of the scale, correlation analysis was carried out between the responses of the students who answered both the original and the translated draft scale. Considering that the number of data at this stage was not very large (n=13) and the need to apply non-parametric tests, the Spearman's rho correlation coefficient was evaluated. The calculated Spearman's rho ($r= 0.788$, $n=13$, $p<0.001$) indicates a high level of correlation (Cohen, 1988). Then, item analyzes and validity and reliability analyzes of the translated draft scale were carried out.

Validity analysis was performed with Confirmatory Factor Analysis, and reliability analysis was performed by calculating the internal consistency coefficient (Cronbach alpha). It was also examined whether the scores obtained from the sample differed by various demographic data (gender, department of education and grade level of education). The findings obtained as a result of the analyzes are presented below.

Ethical Principles

Ethics committee permission for this study was obtained from Sakarya University Ethics Committee with the decision dated 10.11.2021 and numbered 01/10.

FINDINGS

After the draft scale was obtained, the data obtained using this scale were first examined in terms of whether they showed normal distribution and whether they contained extreme values. Tests such as Shapiro-Wilk or Kolmogorov-Smirnov, which are used to test the normal distribution, are used when the data is continuous (Uysal & Kılıç, 2022). However, in most of the studies in the field of social sciences, as in this study, the data that can be obtained with a scale cannot fully fulfill this condition since they can only take certain values. According to Tabachnick and Fidell (2013), for a variable to be considered continuous, it must contain at least seven categories. For this reason, it was determined whether the data showed normal distribution or not by examining the kurtosis and skewness values. At the same time, whether there were extreme data was examined by calculating the Mahalanobis distance and 15 data were determined to be extreme data and were excluded from the scope of the analysis. For the remaining 227 data, both the kurtosis and skewness values were between -1.5 and +1.5, and the analysis was continued by accepting that they showed normal distribution (Tabachnick & Fidell, 2013). Thus, the prerequisites of Confirmatory Factor Analysis were checked.

Confirmatory Factor Analysis was used to verify the factor structure of the translated draft scale. For this, AMOS 24 program was used. As a result of the analysis of the path diagram drawn using the factor structure of the original scale, it was determined that the standardized regression coefficient of one item (Item 9) was low (0.462). It is not desirable for standardized regression coefficients to be less than 0.5 (Hair et al., 2006). In addition, the extent to which the item contributes to reliability should also be considered while making the evaluation (Cohen, 1988). The extent to which this item affects reliability was investigated by examining the internal consistency (Cronbach alpha) coefficient. It was seen that

if this item was deleted, the coefficient would increase from 0.795 to 0.883, and it was decided to remove this item from the scale. The path diagram of the Confirmatory Factor Analysis of the scale can be seen in Figure 1 and the fit index values obtained as a result of the analysis can be seen in Table 2.

Figure 1

Confirmatory Factor Analysis of the scale

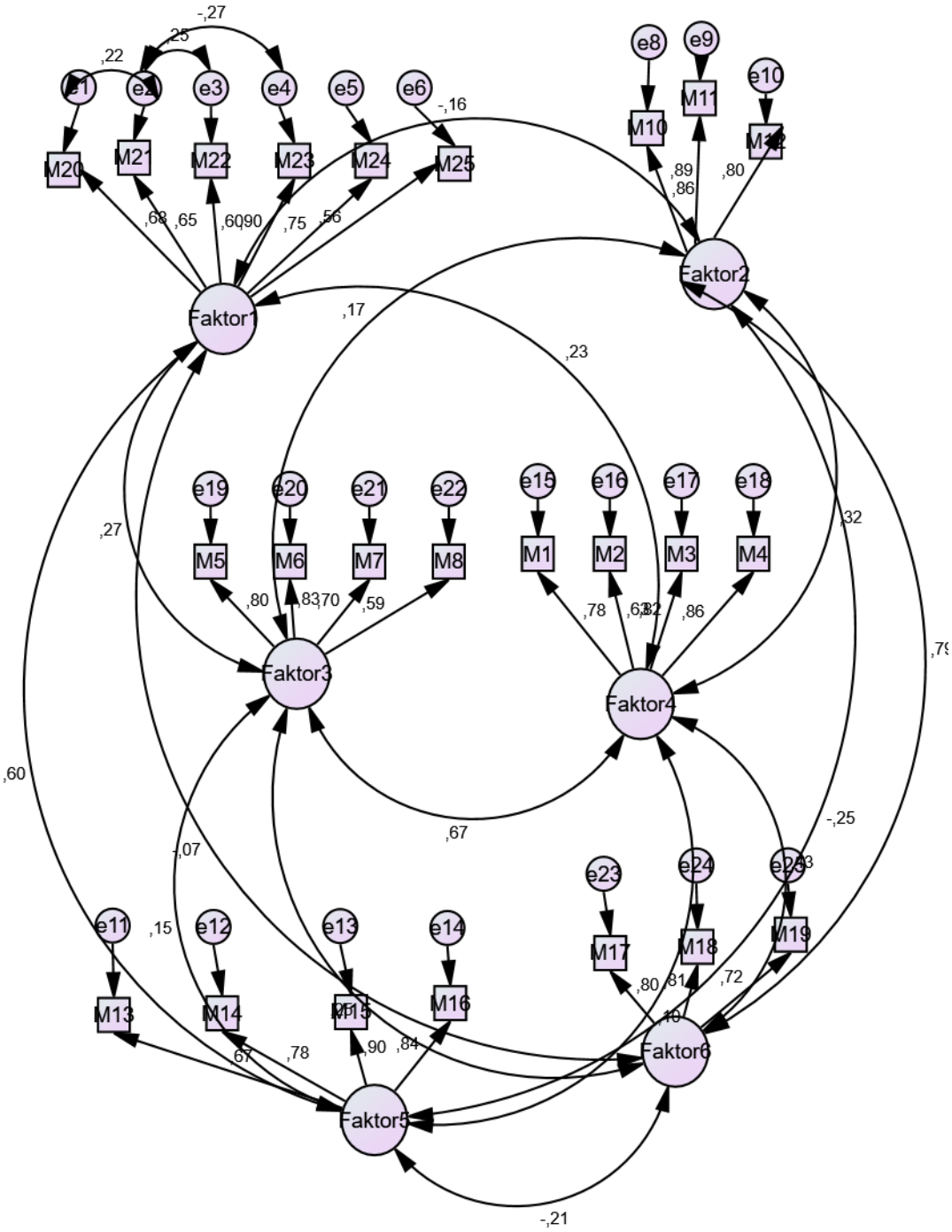

Table 2

Values of Fit Indices obtained by Confirmatory Factor Analysis

Fit index	Value	Range of the fit index	Interpretation
χ 2/df	1.867	χ 2/df≤3 Perfect fit χ 2/df≤5 Acceptable fit	Perfect fit
AGFI	0.862	AGFI≥0.90 Perfect fit 0.85≤AGFI≤0.89 Acceptable fit	Acceptable fit
GFI	0.865	GFI≥0.90 Perfect fit 0.85≤GFI≤0.89 Acceptable fit	Acceptable fit
IFI	0.932	IFI ≥ 0.95 Perfect fit 0.90≤IFI ≤ 0.95 Acceptable fit	Acceptable fit
CFI	0.931	CFI ≥ 0.95 Perfect fit 0.90≤CFI ≤ 0.95 Acceptable fit	Acceptable fit
RMSEA	0.062	RMSEA≤0.05 Perfect fit 0.05≤RMSEA≤0.08 Acceptable fit	Acceptable fit

As can be seen in Table 2, the fit index values of the adapted scale indicate perfect fit and acceptable fit. Thus, it can be stated that the scale, which consists of 24 items and 6 dimensions, has been confirmed and its construct validity has been ensured.

Then, the internal consistency coefficient (Cronbach alpha) was calculated in the reliability analysis used to investigate the reliability of the scale, and it is given in Table 3 together with the reported coefficients of the original scale.

Table 3

The internal consistency coefficient of adopted and original scales

	Original scale	Adopted scale
Factor 1	0.85	0.85
Factor 2	0.84	0.88
Factor 3	0.88	0.81
Factor 4	0.82	0.85
Factor 5	0.88	0.88
Factor 6	0.83	0.81

As can be seen in Table 3, there are high reliability coefficients (George & Mallery, 2003) for all factors. In this case, it can be stated that the adapted scale is a reliable scale. The final version of the adapted scale is presented in Appendix 1.

It was also examined whether the scores obtained with the scale adapted from the sample within the scope of the study varied according to various demographic data, and for this, various analyzes were performed and the findings were presented. When the mean scores taken from the scale are examined, it is seen that the average for the scale is 3.11, when analyzed on the basis of factors, the lowest mean ($\bar{X}$ = 2.61) is in the Cognitive Engagement factor, which is the fifth factor, and the highest mean ($\bar{X}$ = 3.57) is in the Positive Emotional Engagement in Laboratory Procedures factor, which is the

third factor. Whether the scores obtained from the scale differ according to gender was examined with the independent sample t-test and as a result, both the overall scale (t=-0.440, p>0.05) and the factors of the scale (t=-0.095, p>0.05 for the first factor; for factor t=-0.353, p>0.05, for third factor t=0.299, p>0.05, for fourth factor t=0.126, p>0.05, for fifth factor t=0.016, p>0.05 and for sixth factor t=0.016 =-0.638, p>0.05), it was found that there was no significant difference between the groups in terms of gender.

The analysis of the scores obtained from the scale according to the variable of the department studied was also analyzed with the independent groups t-test. As a result, it was found that the scores obtained from the scale did not change significantly according to the department (t=0.732, p>0.05), but the Behavioral Engagement in Laboratory Procedures factor (4th factor) was in favor of the students studying in Science Education (averageScience = 3.52 and meanClass = 3.28).) was found to be a significant difference (t=2.421, p<0.05).

One-Way Analysis of Variance (ANOVA) was used to determine whether the scores obtained from the scale differed significantly according to the level of education. According to the results, there are significant differences for overall scale (F(3,223)=3.636, p<0.05), Positive Emotional Engagement in Laboratory Procedures (third factor) (F(3,223)=5.123, p<0.05) and Behavioral Engagement factor in Laboratory Procedures (fourth factor) (F(3,223)=11.549, p=0.000). The sources of these differences were examined with the Scheffe test, which is one of the post-hoc tests (since the variances are equally distributed and the sample sizes in the groups are different from each other) and are given in Table 4.

Table 4

Post-Hoc Analysis Findings

Dependent variable	(I) – (J)	Avg. dif. (I-J)	Std. deviation	Sig.
Factor 1	1.year-2.year	0.126	0.130	0.817
	1. year -3. year	0.126	0.135	0.834
	1. year -4. year	0.177	0.133	0.625
	2.year-3. year	0.000	0.105	1.000
	2.year-4.year	0.051	0.103	0.969
	3.year-4.year	0.051	0.110	0.975
Factor 2	1.year-2.year	0.103	0.152	0.928
	1.year-3.year	0.033	0.159	0.998
	1.year-4.year	0.072	0.156	0.975
	2.year-3.year	-0.070	0.125	0.957
	2.year-4.year	-0.031	0.121	0.996
	3.year-4.year	0.039	0.130	0.993
Factor 3	1.year-2.year	0.127	0.093	0.609
	1.year-3.year	0.014	0.098	0.999
	1.year-4.year	0.293*	0.096	0.028
	2.year-3.year	-0.113	0.077	0.543
	2.year-4.year	0.166	0.075	0.184
	3.year-4.year	0.279*	0.080	0.008
Factor 4	1.year-2.year	0.528*	0.095	0.000
	1.year-3.year	0.343*	0.099	0.009

	1.year-4.year	0.490*	0.098	0.000
	2.year-3.year	-0.185	0.078	0.136
	2.year-4.year	-0.038	0.076	0.969
	3.year-4.year	0.147	0.082	0.358
Factor 5	1.year-2.year	0.128	0.161	0.890
	1.year-3.year	0.125	0.170	0.910
	1.year-4.year	0.218	0.166	0.634
	2.year-3.year	-0.003	0.134	1.000
	2.year-4.year	0.090	0.129	0.922
	3.year-4.year	0.093	0.139	0.930
	1.year-2.year	0.227	0.136	0.430
	1.year-3.year	0.222	0.143	0.489
Factor 6	1.year-4.year	0.313	0.140	0.176
	2.year-3.year	-0.004	0.112	1.000
	2.year-4.year	0.086	0.109	0.890
	3.year-4.year	0.091	0.117	0.895
	1.year-2.year	0.176	0.070	0.103
	1.year-3.year	0.134	0.073	0.343
Whole scale	1.year-4.year	0.232*	0.072	0.017
	2.year-3.year	-0.041	0.057	0.915
	2.year-4.year	0.056	0.056	0.794
	3.year-4.year	0.098	0.060	0.444

Accordingly, the significant difference between the overall scores of the scale is between the students who continue their education in the 1st and 4th grades and in favor of the students who continue their education in the 1st grade (1st grade average score = 3.27 and 4th grade average score = 3.11). The significant difference between the scores obtained from the third factor, Positive Emotional Engagement in Laboratory Procedures factor, is between 1st and 4th year students and 3rd and 4th year students, in favor of 4th year students in both cases (1st year average score = 3.69, 3rd year average score=3.68 and 4th year average score=3.40). Additionally, for the fourth factor, the Behavioral Engagement in Laboratory Procedures factor, 1st grade and 2nd grade (1st grade mean score=3.89, 2nd grade mean score=3.36), 3rd grade (1st grade mean score=3.89, 3 There are significant differences between .class average score=3.54), and 4th grade (1st grade mean score=3.89, 4th grade mean score=3.40), and each time in favor of 1st grade.

RESULTS, DISCUSSION AND CONCLUSION

In this study, the General Chemistry Laboratory Student Engagement Scale, originally developed by Smith and Alonso (2020), was adapted into Turkish. The Turkish form of the scale, which retains its 6-dimensional structure as in the original, was obtained by removing an item (I felt anxious about using glassware in the laboratory) that did not have a sufficiently high standardized regression coefficient as a result of the Confirmatory Factor Analysis and at the same time caused an increase in reliability if removed from the scale. The remaining 24 items were confirmed as having acceptable and excellent fit index values. The adapted scale has high reliability coefficients in all dimensions. Thus, it can be evaluated that the adapted scale is a valid and reliable measurement tool.

When the averages of the scores obtained from the scale for the sample from which the data were collected were evaluated, it was determined that the scale average was 3.11. This average is an average that can be considered high and indicates that students' engagement in the chemistry laboratory is high. According to the analysis made on the basis of factors, it is seen that the highest average is in Positive Emotional Engagement in Laboratory Procedures, and the lowest average in Cognitive Engagement in Laboratory Procedures. As a result of the original study (Smith & Alonso, 2020), the researchers stated that the lowest average score was in Negative Emotional Engagement in Laboratory Procedures, and the highest score average was in Behavioral Engagement in Laboratory Procedures. Assessments here are highly dependent on the size of the sample as well as its characteristics of course, and the differences between the results of this adapted scale and the original scale are also due to differences in culture and education system. According to the results of this study, in which students continuing their education in two large/important education faculties of our country are the sample, it is pleasing that student engagement in the chemistry laboratory is at a high level. When evaluated together, it can be interpreted that the students have positive emotions such as excitement and curiosity while performing the operations in the chemistry laboratory. Still, they do not learn or understand the procedures in the laboratory sufficiently (cognitive dimension). In this case, it may be suggested to try to use methods and techniques that will allow more cognitive engagement of students. In a study conducted by Cengiz, Karataş, and Aslan (2007), students were asked to create development files consisting of pre-laboratory and post-laboratory products in the general chemistry laboratory, and the effect of this process on student success was investigated, and it was stated that there was a significant increase in student success. In addition, the use of V-diagrams in chemistry laboratory courses (Çeliks et al., 2008; Nakiboğlu & Meriç, 2000), cooperative learning and peer learning (Ding & Harskamp, 2011), and keeping reflective diaries with feedback (Cengiz & Karataş, 2015) studies showed that they lead an increase in success. There are also studies showing that using the case study method in the chemistry laboratory (Seçkin & Yılmaz, 2014) and quizzes being held at the end of the lab instead of at the beginning (Kılınç Alpat & Altun, 2017) increase the success of students by reducing their anxiety. Therefore, by using the General Chemistry Laboratory Student Engagement Scale obtained at the end of this study, it can be investigated how the methods and techniques used in the mentioned studies and reported to increase student achievement in the chemistry laboratory affect student engagement.

When the data obtained with the scale adapted to Turkish within the scope of the study were evaluated in terms of gender, no significant difference was found, while there was a significant difference in favor of the participants studying science teaching in the dimension of Behavioral Engagement in Laboratory Procedures according to the variable of the department. Considering that the students studying in the science teaching department are more familiar with the laboratory, due to the fact that the students in the science teaching department are more familiar with the laboratory, as compared to the students in the classroom teaching department (YÖK, 2018), it can be said that spending more time in the laboratory or being exposed to lab operations has a positive effect on engagement. However, another important point to consider here is that the previous student backgrounds of the students who choose these two departments are also different from each other, and that students who generally prefer science teaching are more inclined to or prefer science courses. According to the variable of the year studied, there was a significant difference between the 1st year students and 4th year students and in favor of the 1st year students throughout the scale. When the curricula of the science teaching and classroom teaching departments of the education faculties, which

are the sample, are examined (YÖK, 2018), it is seen that the students use the chemistry laboratory intensively in the 1st year. This situation decreases towards the end of their education life. From this result, it can be deduced that exposure is a factor that increases engagement.

Researchers who developed the original scale state that the scale can be used to evaluate students' experiences after various chemistry experiments and to make necessary adjustments (Smith & Alonso, 2020). The scale adapted to Turkish in this study can be similarly used to evaluate students' experiences in these experiments after various chemistry experiments. At the same time, considering that students' emotional, behavioral and cognitive engagement in the process is necessary for meaningful learning (Fredricks, Blumenfeld, & Paris, 2004), various assessments can be made, and necessary adjustments can be made. Similarly, the adapted scale can be used to examine how changes in laboratory processes affect students' engagement.

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How Should I Start Research in Cyber Security? Suggestions for Researchers According to Bibliometric Analysis Data

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Abstract

The aim of this study is to discover the research trends in the field of cyber security with performance analysis and to reveal the intellectual structure of the field of cyber security with scientific mapping. For this purpose, articles published in the field of cyber security between 1998-2021 in the WoS database were examined. The research was carried out in accordance with the bibliometric analysis guide. In the data collection phase, 1,631 articles were included in the study by taking into account the criteria determined among 15,781 studies using the PRISMA procedure. R program was used in bibliometric analysis. According to the findings of the study, there has been a significant increase in article productivity in the field of cyber security after 2020. Although IEEE Access is the journal with the highest number of publications in the field, IEEE Transactions on Smart Grid ranks first according to h-index and g-index values. Considering the topics studied according to the years, it is seen that in the first years, issues related to the law such as cybercrime and cyber terrorism were examined, and recently, in addition to these, current technological issues have been included. It is observed that the most effective publication is 'The Internet of Things for Health Care: a Comprehensive Survey' by Islam et al. which examines the security of the Internet of Things in health care, which is also a current issue.

Keywords

Cyber security, bibliometric analysis, current research trends, performance analysis.

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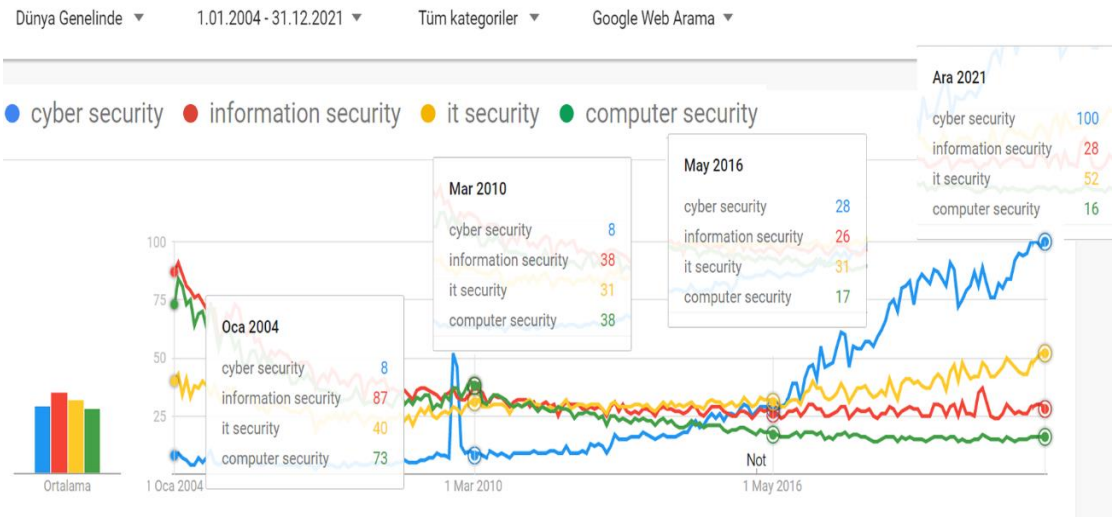
INTRODUCTION

There has been a significant surge in internet usage due to technological developments and the impacts of the Covid-19 epidemic. While the percentage of households accessing the Internet was 82.5% (TUIK, 2018) according to the results of the Household Information Technologies Usage Survey conducted by the Turkish Statistical Institute (TURKSTAT) in 2018, the results of the 2021 survey indicated that this proportion increased to 92% (TUIK, 2022). The number of people exposed to cyber security threats increases with rising internet usage. All users, regardless of age, are exposed to various cyber security threats while spending significant time on the Internet. Multiple terms are used to describe such threats that Internet users are exposed to in their daily lives. Terms such as cyber security, information security, online security, online protection, and internet security are used interchangeably in the literature (Schatz et al., 2017; Quayyum et al., 2022). The analysis conducted via Google's search trends (Google Trends) revealed the changing trends in search of these terms in the web environment (Fig. 1).

Figure 1

Google search trends from 2004-2021 (Source: https://trends.google.com/trends/explore?date=2004-01-01%202021-12-31&q=cyber%20security,information%20security,it%20security,computer%20security)



Search trends is a free service provided by Google, and it reveals how frequently search terms are used. It provides data on which periods have the most searches for the chosen keyword(s) within a specific date range. Although these trends are indicative only, search engine-based data is considered beneficial and valuable for identifying trends (Schatz et al., 2017) as indicated in previous studies (Choi & Varian, 2012). The trendlines in Figure 1 were created by comparing the terms "cyber security," "information security," "it security," and "computer security" between 01/01/2004 and 12/31/2021 in all categories worldwide. Since Google started the trends year range from 2004, the start date was set to 2004. The search result can be accessed at the URL found in the reference section of Figure 1. Figure 1 demonstrates that the terms "information security" and "computer security" were the most used terms of 2004 and 2010. In 2016, while the use of "cyber security" increased, the use of "information

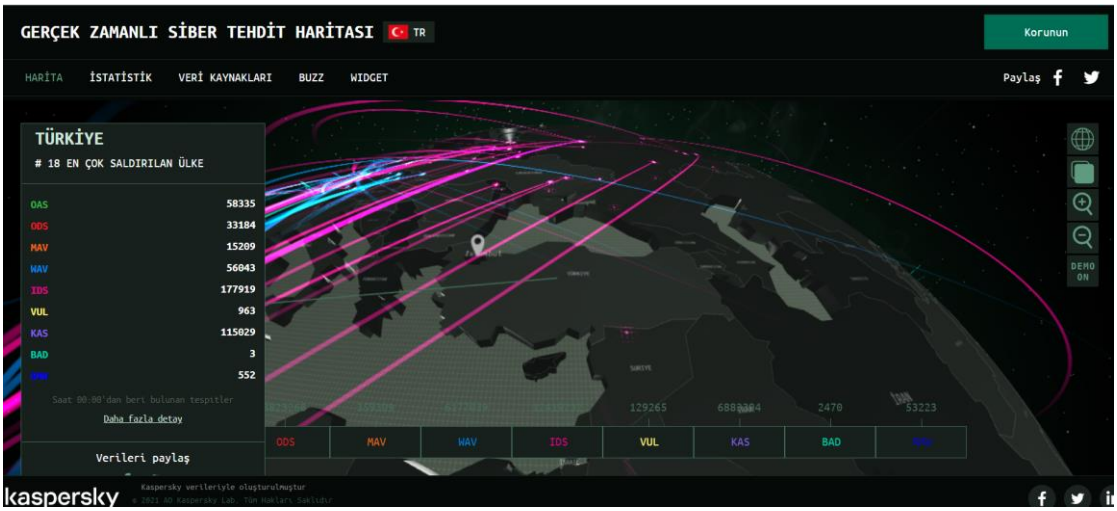
security" showed a decline, yet they were the most frequently used terms. At the end of 2021, however, there was a significant rise in the use of "cyber security," which became the most used query. Therefore, the term cyber security was preferred in this study.

Cyber security protects information, information processing, or storage systems by providing hardware and software solutions (Tam et al., 2021). Although there is no standard definition of cyber security, the International Telecommunication Union (ITU) defines it as the collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance, and technologies that can be used to protect the cyber environment and organization and user's assets. (ITU, 2022). It involves institution, organization, and user's assets, connected computing devices, personnel, infrastructure, applications, services, telecommunications systems, and the totality of transmitted and/or stored information in the cyber environment. In short, the term cyber security can be defined as protecting the Internet of things (IoT), networks, and programs against internal or external threats.

Cyber security is a significant issue for institutions and organizations' infrastructure. It is also vital for individuals who want to keep their information, data, and devices secure. In today's world, a large amount of data is stored on IoT devices, and countries are becoming more dependent on technology. As a result, countries become vulnerable to cyber-attacks. According to The Cyber security and Infrastructure Security Agency (CISA, 2022), attacks that occurred every 39 seconds in 2019 increased dramatically to every 11 seconds in 2021. In addition, according to Cyberthreat Real-Time Map by Kaspersky, our country, which ranked 19th among the most attacked countries in 2021, ranked 18th on February 23th, 2022, as demonstrated in Fig. 2.

Figure 1

Kaspersky real-time Turkey cyber threat map (Source: https://cybermap.kaspersky.com/tr)



Understanding cyber security begins with the basic assumption that anyone can be a target for attacks by cybercriminals in cyberspace (Sule et al., 2021). While there are also targeted attacks, most attacks are un-targeted. Individuals, institutions, or countries may cause severe problems by gaining access to data or organizing assaults through cyberattacks. It is possible to share sensitive information, change

data, and even attack countries' energy or natural gas lines. There have been severe cyberattacks on governments throughout history. In this regard, cyber security threats jeopardize a country's security, economy, and health, causing monetary and moral costs. At this point, education is a savior. Offering cybersecurity training to end users is one way to reduce losses. It's an unfortunate fact that, while cybersecurity in Education is necessary to protect against financial loss and prevent disruption, it's also crucial to protect students from harm.

Besides the importance of education, governments bear significant responsibility for reducing the risk of cyberattacks. Countries all around the globe develop cyber security plans both at a national and international level and implement cyber security policies. Similarly, in our country, the Ministry of Transport, Maritime Affairs, and Communications issued the National Cyber security Strategy and Action Plan for 2020-2023 in 2020. The action plan includes the cyber security objectives that our country has determined within its vision 2023. However, although cyber security is one of the most critical challenges countries face today, studies on cyber security are limited. It is vital to emphasize cyber security studies and assure their continuity to comprehend the significance of cyber security, anticipate potential problems, discover solutions as quickly as possible, and ensure security. Also, those wishing to pursue a cyber security-related research career should be aware of the scope of cyber security research areas to design studies so that they make fundamental contributions to the discipline (Suryotrisongko & Musashi, 2019). Therefore, the current study examines the trends in cyber security studies on a large scale through bibliometric analysis, referring to the significance of cyber security.

There are very few bibliometric analyses on cyber security studies published internationally (Cojocaru & Cojocaru, 2019). Some of these analyses have focused on applying cyber security in specific research areas such as healthcare (Bradea et al., 2015; Jalali et al., 2019). Others focus on the bibliometric analysis of various aspects and components of cyber security such as big data, malware (Razak et al., 2016), mobile forensics (Gill et al., 2018), cybercrime victimization (Ho & Luong, 2022), cyber behavior (Serafin-Plasencia et al., 2019), cyber security, cyber parental control (Altarturi et al., 2020). Ho and Luong (2022) examined the bibliometric analysis of 387 Social Science Citation Index (SSCI) articles on cybercrime victimization on the Web of Science database during 2010-2020 (Ho & Luong, 2022). Their study identified research trends and distribution of publications by five main areas, including time, prolific authors, leading sources, active institutions, and leading countries/regions. Altarturi et al. (2020) examined a bibliometric analysis of publications on cyber parental control on Scopus and WoS between 2000 and 2019 (Altarturi et al., 2020). They determined the trends of articles, books, book chapters, and conference proceedings in terms of author, country, and collaborative network. Serafin-Plasencia et al. (2019) examined the bibliometric analysis of cyber behavior articles published in four journals on the Scopus database between 2000 and 2018 (Serafin-Plasencia et al., 2019). Their study identified trends of the most productive country, scientific collaboration, most prolific authors, and the most frequently used words. Moreover, Cojocaru and Cojocaru (2019) also explored the total number and geographical distribution of publications on cyber security in Eastern Europe, the cyber security document types of the authors in the Republic of Moldova, the languages used, the institutions of the authors, and publication sources using the database of the Republic of Moldova and Spocus Elsevier and WoS (Cojocaru & Cojocaru, 2019). When the studies are examined, although there are several bibliometric analysis studies published on cyber security and its sub-themess, it seems that there is a need for further studies that reveal the status of cyber security at the international level.

Reviewing a vast volume of literature aids in identifying research themes and gaps in the literature, which is helpful for prospective future studies (Tranfield et al., 2003). Given the importance of cyber

security for countries, this study attempts to fill a gap in the field by examining existing publications and disclosing the current state of cyber security research trends. In this regard, the present research focuses on cyber security studies published between 1998 and 2021 and indexed in the Web of Science (WoS) database. The dates were chosen based on the established criteria, including the date of the first cyber security research in WoS. Furthermore, the current study is crucial in terms of detecting the gaps and significant aspects in the discipline, as it indicates the present condition, academic performance, and intellectual framework of cyber security research. This study also reveals the most influential constituents of the field, including the productivity of cyber security studies, the most cited journals, publications, and explored themes. The study's findings may inspire further research in the field. This study also provides practical information for researchers who wish to study cyber security to understand the basis of the concept better and discover new trends in cyber security. Seeing publication trends in the field of cyber security can also contribute to increasing cyber security measures and awareness. Determining scientific fields' intellectual structure and status is essential for research, policymaking, and implementation (Aria & Cuccurullo, 2017).

Therefore, the aim of this study is to discover research trends in the field of cyber security with performance analysis and to reveal the intellectual structure of the field of cyber security with scientific mapping, especially for researchers who want to work in the field of cyber security. While performance analysis explains the contributions of research components to the field, scientific mapping focuses on the relationships between research components (Baker et al., 2021; Donthu et al., 2021;). In this regard, the current study was designed by considering the following two research questions:

1. What is the performance analysis of the papers published in cyber security?

1.1. What is the productivity trend of the papers in the field of cyber security by years?

1.2. What is the performance status of journals that publish cyber security studies in the field?

2. What is the intellectual state of the cyber security field?

2.1. What is the relationship between themes in the field of cyber security?

What are the most influential publications in the field of cyber security?

METHOD

In this section, the information about the research method, the universe-sample-study group and the data collection tool are presented respectively.

Research design

A systematic literature review and bibliometric analysis were conducted as part of the study's scope. Bibliometric analysis is a type of statistical analysis that employs data from a database to provide in-depth information on the development of a specific field (Leung et al., 2017). Based on the social, intellectual, and conceptual frameworks of the disciplines, it is an acceptable approach to examine the evolution of scientific disciplines, including themes and authors. (Donthu et al., 2021). The bibliometric analysis allows for the tracking of studies, authors, institutions, and scientific flow concerning a certain scientific topic (Martí-Parreño et al., 2016). Bibliometric studies enable measuring the basic features of scientific publications in certain criteria such as citation, author, co-author, cited bibliography. They also help detect patterns in the study discipline revealing the overall structure of the field through the

interpretation of the findings. (Kasemodel et al., 2016). The research was carried out taking into account the (Donthu et al., 2021) bibliometric analysis guidelines included in the study. Table 1 demonstrates the four stages of the guideline.

Table 1

Bibliometric Analysis Guide (Adapted from Donthu et al., 2021)

Stage 1: Defining purpose and scope	Define the aims and scope of the bibliometric study
Stage 2: Selection of techniques for bibliometric analysis to be used	Select appropriate bibliometric analysis techniques according to the aims of the study
Stage 3: Data collection for bibliometric analysis	Design the search query based on the scope defined in step 1 Select the database according to the adequacy of the scope Collect bibliometric data according to bibliometric analysis technique Clear data.
Stage 4: Report bibliometric analysis findings	Performance Analysis (Summarize performance of productive research components using publication, citation, and publication-citation criteria) Scientific Mapping (Summarize bibliometric structure and intellectual structure using scientific mapping techniques and bibliometric analysis development techniques) Create a bibliometric summary and write a discussion of the findings along with the results

Table 1 presents the first step of the study, in which the aim and scope of the study were determined. This study aims to discover the research trends in cyber security through performance analysis and to reveal the intellectual structure of the cyber security field through scientific mapping. Performance analysis examines the contributions of research constituents to a particular field (Cobo et al., 2011; Ramos-Rodríguez & Ruíz-Navarro, 2004). Countless measures for performance analysis exist. The most prominent measures are the number of publications and citations per year or research constituent; wherein publication is a proxy for productivity, whereas citation is a measure of impact and influence. Other measures, such as citations per publication and the h-index, combine both citations and publications to measure the performance of research constituents (Donthu et al., 2021). To determine the intellectual structure of the cyber security field, the relations between the themes were examined through the author keywords. Author keywords are a clear, representative, and concise description of the research content. Therefore, it makes sense to identify emerging trends of research themes and themes by co-word analysis (Zheng et al., 2016). In addition, the most cited publications were examined using co-citation analysis, and the intellectual structure of the field was attempted to be ascertained. Co-citation analysis is a fundamental technique for scientific mapping that is based on the assumption that citations represent the intellectual connections generated when one publication cites another (Appio et al., 2014). It also defines the intellectual structure of a field of knowledge by determining the quantity and authority of the literature cited. In this analysis, a publication's influence is determined by the number of citations it receives. Research questions and sub-research questions

were developed for this aim. In the second stage, techniques for bibliometric analysis were chosen to meet the aims and scope of the study. Performance analysis was conducted in order to determine the number of publications on cyber security per year (number of publications per year) and in which journal the most publications were made. To determine the intellectual structure of the cyber security field, the most cited publications, the relationship between the themes, and the interaction between the authors were examined. The third stage is the collection of necessary data for the bibliometric analysis techniques chosen in the second stage. At this stage, the database is selected, the basic dataset is filtered and the data is exported from the selected database. This stage involves the construction of the study's database (Waltman, 2016). In the third and fourth stages of the study, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) procedure, demonstrated in Table 2, was conducted to collect data, create the dataset and report the data (Moher et al., 2009).

Table 2

PRISMA procedure showing the procedure followed in the research [adapted from Moher et al., (2009)]

dentification	Records identified by database search (n=15.781) AB=((Cyber security) or (Cyber security) or (Cyber-security)	
Screening	Included records (n=15.781)	Excluded records (9.150) Publications Years: 2022 (132) Document Types: Proceedings Papers (8.311), Review Articles (469), Book Chapters (263), Others (124) Language: Russian (65), Spanish (54), Turkish (18), German (15), Others (69)
Eligibility	Records that meet the criteria (n=6.631)	
Included	Records included in the analysis (n=6.631)	

Studies included in the identification phase of the PRISMA in Table 2 were determined by the search conducted on the WoS database. WoS, Scopus, and Google Scholar are databases that provide bibliometric data for literature search (Abrizah et al., 2013; Mingers & Leydesdorff, 2015). WoS is the first database since the 1900s to include the literature and facilitate bibliometric analysis (Mingers & Leydesdorff, 2015). An important feature of the WoS database is that it includes all article types and indexes authors and bibliographic references for each article (Mongeon & Paul-Hus, 2016). When compared to Scopus or Google Scholar, WoS is said to have the most comprehensive and greatest amount of highly cited articles. (Mingers & Leydesdorff, 2015). For this reason, the WoS database was preferred to search for keywords in this study. Using the advanced search section in the Web of Science (WoS) database, a search was conducted within all fields through the following code line typed in the query preview section: AB=((Cyber security) or (Cyber security) or (Cyber-security). The goal of creating this code is to search for terms relevant to cyber security in the abstract section. In the literature, cyber

security is also referred to as Cyber security or Cyber-security. At the identification stage, a total of 15.781 articles were retrieved. During the screening stage, these articles were filtered down according to the excluded criteria (Table 1), and 6.631 entries were obtained during the eligibility stage. Following a review of the study abstracts in the included stage, 6.631 were included in the analysis. The inclusion and exclusion criteria are presented in Table 3.

Table 3

Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Database	WoS	Elsevier's Scopus, Google Scholar, IEEE Explore, ScienceDirect, Association for Computing Machinery (ACM), Springer
Time range	1998-2021	2022
Language	English	Russian, Spanish, German and other languages
Document type	Article	Paper, book chapter and others

The fourth and final stage is to perform the bibliometric analysis and report the findings. At this stage, one or more bibliometric or statistical software tools are used for data analysis. The most used visualization tools are BibExcel, Gephi, Pajek, VOSviewer, Excel, HistCite, SciMat, and the R bibliometrics library. R is a free and open-source tool and offers several packages for effective bibliometric analysis (Aria & Cuccurullo, 2017; Donthu et al., 2021; Firdaus et al., 2019). In this study, R was preferred because it is a well-known software for statistical computing, is free, and allows the integration of various statistical and visualization packages.

FINDINGS

Research findings should be included in this section. APA6 version should be followed for table, shape, graphic, picture, diagram etc. and their impressions. For this, the author guidelines section should be read. Findings can be prepared in sub-headings.

In this section, the findings corresponding to the two research questions determined at the beginning of the study are presented respectively.

Performance Analysis Of The Papers Published On Cyber Security

The performance analysis of the papers published cyber security field was examined according to their productivity trends and the performance status of the journals, and the findings were presented.

Productivity Trend of The Cyber Security Papers Per Year

The study investigated the productivity trend of the cyber security papers per year, and the findings are presented in Figure 3.

Figure 3

Cyber security annual scientific production (1998–2021)

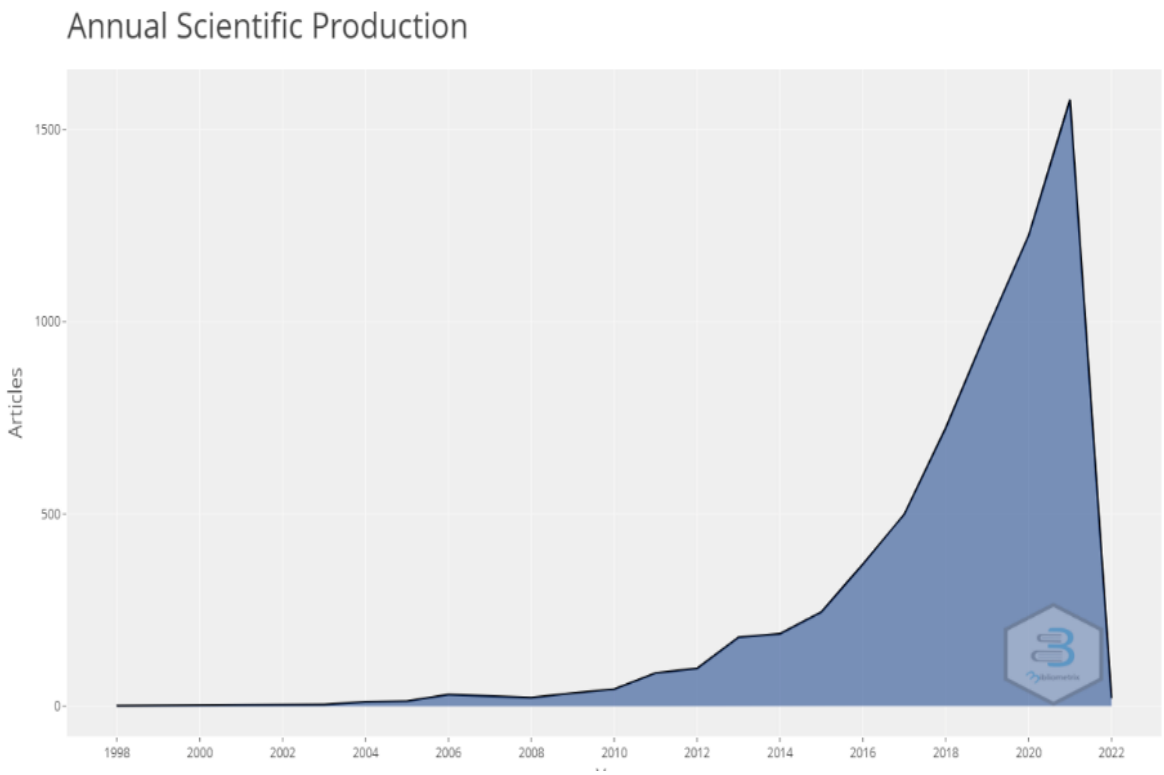


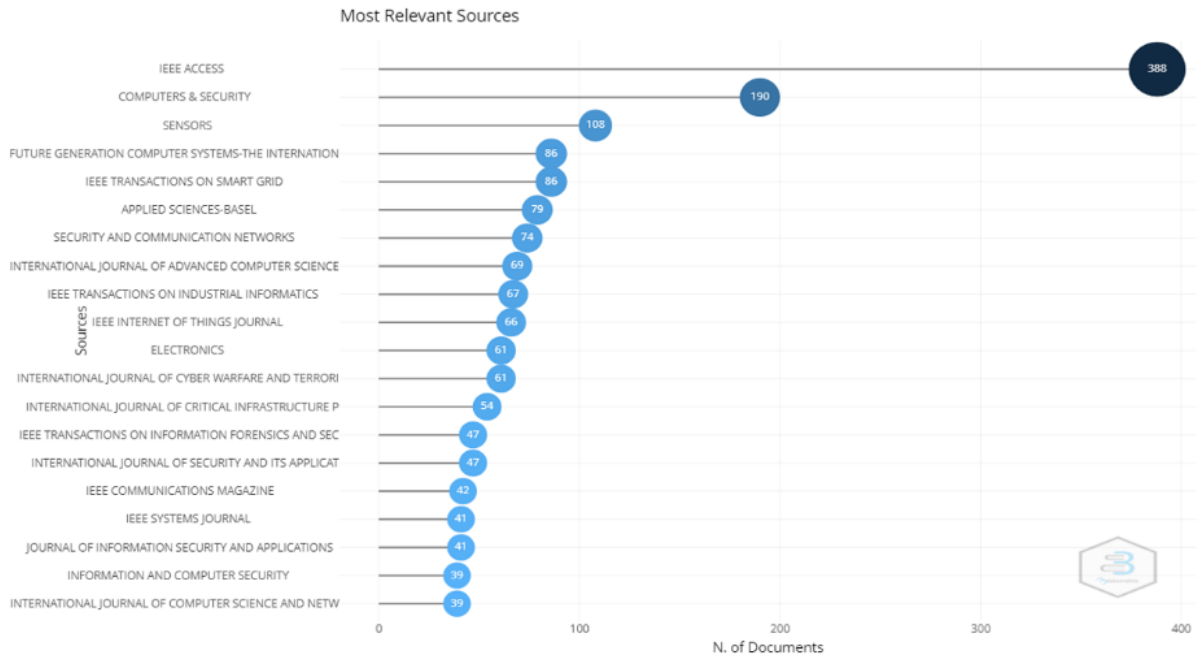
Fig. 3 shows an increasing trend from 1998 to 2021 in cyber security papers found in the WoS database. Although there were minor fluctuations in the number of articles published each year until 2019, there was a significant increase in the number of publications published after 2019. The total number of papers published during this period is 6631, which may be divided into two sub-periods as 1998–2018 and 2019–2021. Although the first period covers twenty years, the number of papers published (2572) is smaller than the number of articles published (4059) in the second era, including the last three years. Cyber security research showed a remarkable development with 1023 articles in 2019 and reached its peak with 1736 articles published in 2021.

The performance status of journals publishing cyber security studies in the field

The leading journals in terms of the number of publications linked to cyber security are investigated in Fig. 4 to establish the performance status of the journals that publish cyber security studies. With 388 articles, IEEE Access takes the first position, followed by Computers & Security with 190 articles, and Sensors in third place with 108 articles.

Figure 2

The relevant sources in terms of the number of publications



The number of papers published is an essential measure for determining the journal's productivity. However, it is not a sufficient criterion on its own since it does not give information regarding the journal's importance or its impact (Akgün, 2017). As a result, the impact of the top ten journals according to the number of publications is investigated in Table 4 below using the h-index, g-index, total number of citations, and publication year. Evaluating the h-index alone would be an inaccurate measure of research evaluation, especially for highly cited journals. A combination of h-index and g-index gives a better measure of global citation performance and individual research impact (Ali, 2021). In his work (Egghe, 2006), Egghe (2006) suggests combining the g-index with the h-index. As a result, the h and g index values were analyzed together in the study.

Table 4

Impact of the journals

Journals	NP	h_ndeks	g_indeks	TC	PY_Start
IEEE Transactions on Smart Grid	86	33	62	3896	2010
IEEE Access	388	29	60	5014	2014
IEEE Internet of Things Journal	66	25	55	3066	2014
Computers & Security	190	32	54	3670	1999
Future Generation Computer Systems-The International Journal of Escience	86	25	46	2336	2012
IEEE Transactions on Industrial Informatics	67	22	39	1644	2013
Applied Sciences-Basel	79	9	16	352	2017
Security and Communication Networks	74	9	15	352	2011

International Journal of Advanced Computer Science and Applications	69	5	7	87	2013
Sensors	108	5	6	48	2018

NP: Number of publication, TC: Total citations, PY_start: Publication year start

Although IEEE Access has the most citations and articles, IEEE Transactions on Smart Grid is the most influential journal in terms of h-index and g-index values. IEEE Access is ranked second, and IEEE Internet of Things Journal is ranked third. Journals (according to 2021) have a minimum of three and a maximum of twenty-two years of history. It is noteworthy that the Computers & Security journal, which ranks fourth in Table 4 and has been published since the notion of cyber security first evolved, has 190 articles on the topic. In contrast, IEEE Access journal, which has been publishing for seven years, has 388 publications. Furthermore, when the IEEE Access journal's g-index and h-index values are considered, it is more influential than the Computers & Security journal.

The intellectual state of the cyber security field

The relationship between themes in the field of cyber security

A co-word analysis was performed to uncover the existing relationships between the themes in cyber security and to detect thematic trends. The results are presented in Fig. 5.

Figure 5

Use of words by years

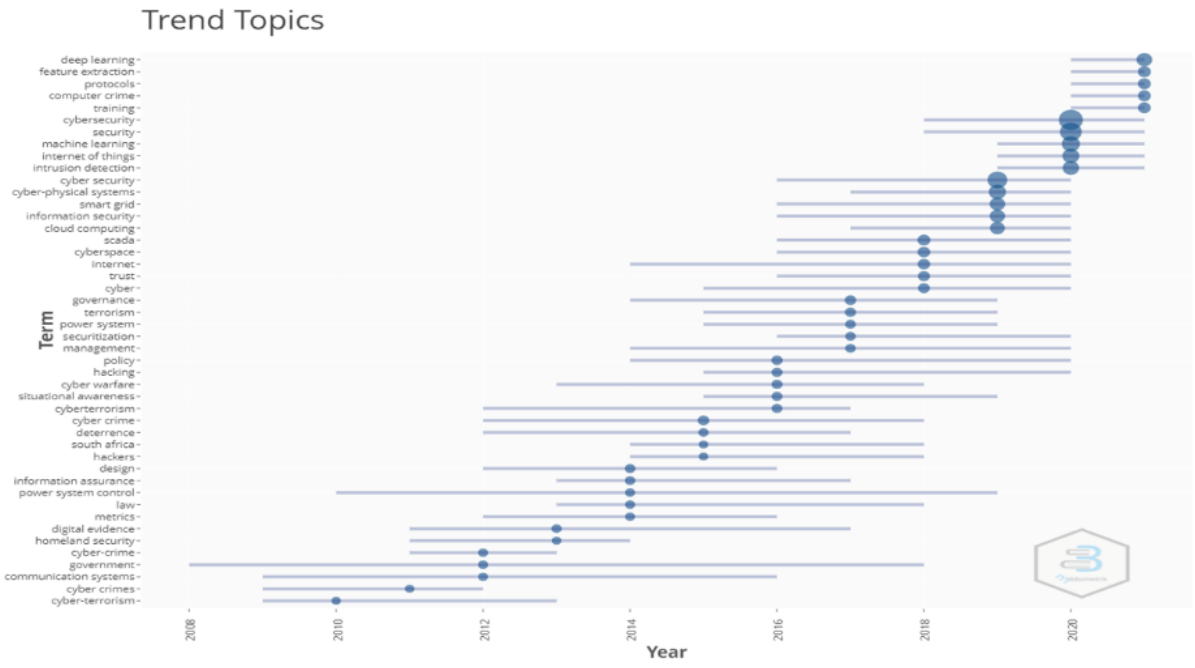


Fig. 5 illustrates the years in which the words were used and which words were used frequently per year. The following terms were used between 2008 and 2021: government, cyber-terrorism, cyber crimes, communication systems, power system control, digital evidence, homeland security, design, metrics, determination, cyberterrorism, information assurance, law, cyber warfare, hackers, south

Africa, policy, governance, management, internet, hacking, situational awareness, terrorism, power system, cyber, securitization, cyberspace, trust, cyber security, smart grid, information security, cyber-physical systems, cloud computing, security, machine learning, internet of things, intrusion detection, deep learning, feature extraction, protocols, computer crime, and training. Furthermore, the word government has been examined in cyber security for a decade. Also, cyber crime (cybercrime, cyber crimes) has been addressed between 2008 and 2018 and has recently obtained its position in the literature as computer crime. The most frequently used words per year are presented in Table 5.

Table 5

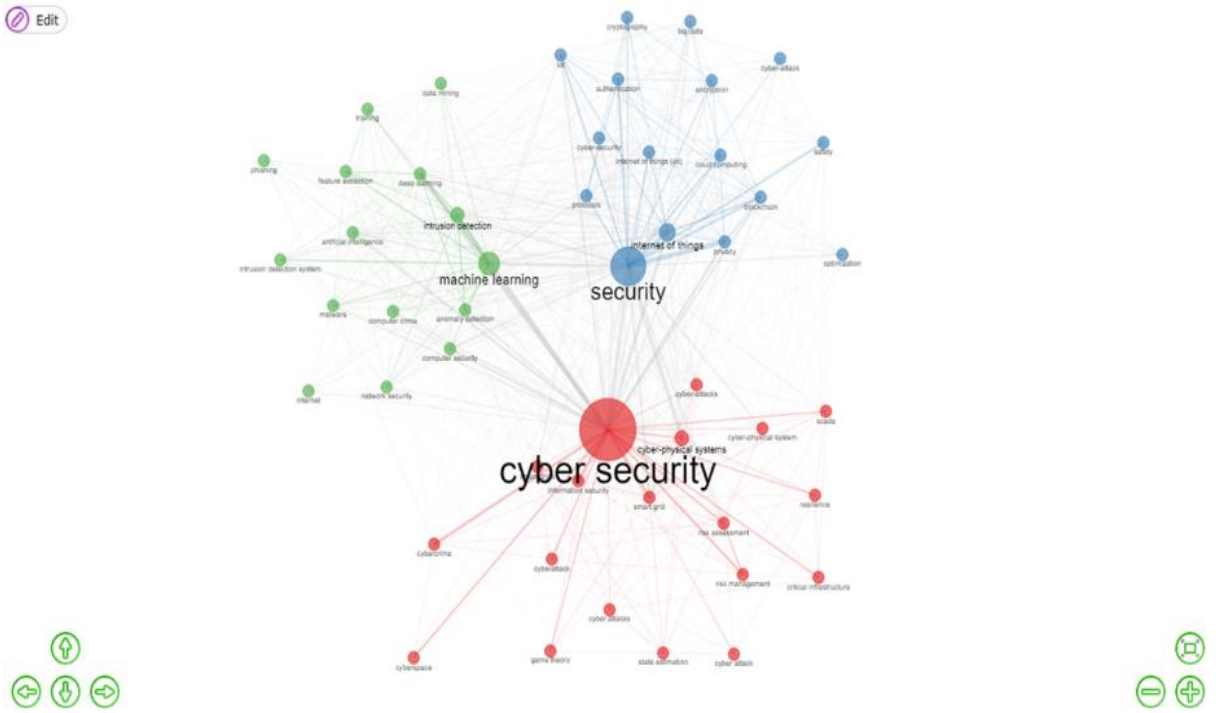
Most frequently used words by year

Year	Words
2010	Cyber-terrorism
2011	Cyber-crimes
2012	Cyber crimes, communication systems, goverment
2013	Digital evidence, homeland security
2014	Design, metrics, law, power system control, information assurance
2015	Cyber crimes, deterrence, hackers, south africa
2016	Cyberterrorism, cyber warfare, policy, hacking, situational awareness
2017	Management, securitization, governance, terrorism, power system
2018	Cyber, trust, internet, cyberspace, scada
2019	Cyber security, cyber-physical systems,smart grid, information security
2020	Cyber security, security, machine learning, internet of things, intrusion detection
2021	Deep learning, feature extraction, protocols, computer crime, training

A co-occurrence analysis demonstrated the relationship between the keywords in Table 5. Fig. 7 shows the findings of the investigation, which highlight some of the main themess in the field of cyber security and their interrelationships. The size of the circles represents the impact of the word clusters and the frequency with which the authors use them in the field. A line connects words to the cluster based on the strength of their association with it. The thickness of the line indicates the intensity of the word's association with the cluster in which it is located. The most commonly used terms were grouped in three clusters, as seen in Fig. 7. Cyber security, security, and machine learning have the largest and most effective word clusters.

Figure 3

Cyber security keywords co-occurrence network



The three clusters (cyber security, security, machine learning) are related to one another and the words researched. The relationship of the terms to the main cluster is shown in Table 6.

Table 6

The relationship of the words to the clusters

Clusters	Words
Cyber Security (1)	cyber-physical systems, smart grid, information security, risk management, cybercrime, cyber-attacks, cyber-physical system, game theory, risk assessment, critical infrastructure, scada, cyber attacks, cyber attack, cyberspace, resilience, smart grids, state estimation
Security (2)	Internet of things, blockchain, privacy, cloud computing, cyber-security, authentication, big data, protocols, safety, encryption, cyber-attack, cryptography, optimization
Machine learning (3)	Intrusion detection, deep learning, anomaly detection, computer security, malware, artificial intelligence, network security, intrusion detection system, feature extraction, computer crime, training, phishing, data mining, internet

Regarding cyber security, cyber-physical systems, smart grids, and information security are closely intertwined. In terms of security, IoT, blockchain, and privacy; in terms of machine learning, intrusion detection, deep learning, and anomaly detection have a tight link. These connections demonstrate the diverse points of view on the investigation of the topic.

The most influential publications in the field of cyber security

The most influential publications in the field were investigated with co-citation analysis to reveal the cyber security field's intellectual status, and the five most-read papers ranked according to citation are given in Table 7.

Table 7

Top five most read papers ranked according to citation

Article Title	Authors	Year	DOI	TC
The internet of things for health care: a comprehensive survey	Islam, S. R., Kwak, D., Kabir, M. H., Hossain, M., & Kwak, K. S.	2015	10.1109/ACCESS.2015.2437951	1037
A survey on internet of things: architecture, enabling technologies, security and privacy, and applications.	Lin, J., Yu, W., Zhang, N., Yang, X., Zhang, H., & Zhao, W.	2017	10.1109/JIOT.2017.2683200	970
A survey of data mining and machine learning methods for cyber security intrusion detection	Buczak, A. L., & Guven, E.	2015	10.1109/COMST.2015.2494502	824
Cyber–physical security of a smart grid infrastructure	Mo, Y., Kim, T. H. J., Brancik, K., Dickinson, D., Lee, H., Perrig, A., & Sinopoli, B.	2011	10.1109/JPROC.2011.2161428	615
Cyber–physical system security for the electric power grid.	Sridhar, S., Hahn, A., & Govindarasu, M.	2011	10.1109/JPROC.2011.2165269	577

With 1037 citations, the paper published by Islam et al. in 2015 is the most read according to Table 7. Also, Lin et al. published an article in 2017 with 970 citations. Buczak and Guven's work from 2015 ranks third with 824 citations. The paper by Mo et al., published in 2011, is in fourth place with 615 citations, while the article by Sridhar et al., published in 2012, is in fifth place with 577 citations. In general, current themes in cyber security have been examined, such as the internet of things, machine learning, and big data.

RESULTS, DISCUSSION AND CONCLUSION

This study aimed to discover the research trends in cyber security through performance analysis and reveal the field's intellectual structure via scientific mapping. The contributions of research constituents to the field were analyzed using performance analysis, and the intellectual structure was

examined using scientific mapping, and the findings were presented. The findings were discussed in this perspective considering the research questions.

To establish the performance of articles published in cyber security, the article productivity trend per year and the performances of the journals in which the articles were published the most were investigated. When the article productivity per year in cyber security was evaluated, a fluctuating trend was identified between 1998 and 2021. The number of articles surged dramatically in 2020, after a slow increase until 2018. It is believed that the steady growth till 2018 is due to countries having technology, using technology, and having access to the internet. Given that the internet connects us to the cyber world, a lack of access to technology and internet connection will minimize our vulnerability to cyberattacks. Studies show that the increased usage of information technology and other communication devices has a favorable impact on the expanding trend in cyberspace research (Altarturi et al., 2020; Leung et al., 2017; Serafin-Plasencia et al., 2019;). Given the significant increase in 2020, it's reasonable to assume that the reason is a global pandemic and a better understanding of the necessity of cyber security for both individuals and countries. Cyber-attackers always wait for the best time to strike. Natural disasters, continuing crises, and major public events are all instances of such circumstances. (Tysiac, 2022). As a result of the pandemic, there has been a significant increase in internet usage, and individuals of all ages have been forced to transition to the online environment in many areas, including education, health, trade, banking, lifestyle, and business life. Therefore, the frequency of cyberattacks in the cyber environment has grown, as has the likelihood of successful cyberattacks. (Lallie et al., 2021; Williams et al., 2020). This increase is thought to encourage researchers to conduct cyber security research, thus affecting the number of publications published after 2020.

The leading journals in terms of the number of publications dedicated to cyber security were reviewed in order to establish the performance status of the journals that publish cyber security articles. Accordingly, IEEE Access is ranked top, Computers & Security is second, and Sensors is third. When the influence of the journals is examined, however, this ranking appears to have shifted. IEEE Transactions on Smart Grid ranked first, IEEE Access second, and IEEE Internet of Things Journal third. The disparity in the number of articles is assumed to be related to the publication policies, despite the fact that these journals are the three most influential journals according to the h index and g index values. Generally, the Institute of Electrical and Electronics Engineers (IEEE) publishes these journals (IEEE). IEEE is a non-profit technical organization committed to the development of engineering theory and practice in electrical, electronics, computer, automation, telecommunications, and a variety of other fields. Journals are also included in the Engineering & Computer Science category on Google Scholar. It is possible to state that research on cyber security is mostly conducted in the field of engineering. Also, researchers who wish to publish in cyber security should prefer these journals according to the scope and publication policies of the journals.

Co-word analysis was used to examine the relations between the themes in order to determine the intellectual status of the cyber security field. Considering the terms studies focused per year, the studies initially focused on a certain theme such as cyberterrorism, cybercrime, government. However, the focus then evolved into the following themes: information security, computer security, computer crime, deep learning, machine learning, cloud computing, etc. The reason for this is believed to be that as computers and the internet become more prevalent in our lives, governments become more vulnerable to computer-based attacks. Society has witnessed a rapid and frightening expansion in both information and communication systems, as well as information violations, as a result of the advent of

the internet and social media. Cybercrime progresses along a path that includes advancements in information and communication technology, computer generations, network expansion, and the emergence of anti-security methods (Li, 2017). As a result, it is reasonable to conclude that researchers focus primarily on criminal aspects of cyber security. Today, however, researchers' focus is on current issues related to cyber security such as deep learning, internet of things, machine learning, etc.

To identify the most influential publications in the field of cyber security and to understand the intellectual dynamics of the field, co-citation analysis was carried out. Co-citation analysis was used to determine at the most influential publications on cyber security, and the most cited paper was 'The Internet of Things for Health Care: a Comprehensive Survey' by Islam et al. (Islam et al., 2015). The paper was published in the journal IEEE Access in 2015. From a healthcare perspective, the study examines many security and privacy issues of the IoT, including security requirements, threat models, and classification of the attacks. Although the Internet of Things (IoT) is widely referred to in healthcare (Samhale, 2022) it has yet to be thoroughly studied theoretically and empirically in the context of security. Security is critical for IoT applications, according to Al-Fuqaha et al. (Al-Fuqaha et al., 2015). Calvillo-Arbizu et al. (2021) noted in their study that IoT in healthcare services has significant potential, although it lags behind other fields. IoT is one of the most popular technological developments in healthcare, according to Ansari et al. (Ansari et al., 2020), although its implementation seldom matches sectorel standards. As a result, the article's influence may be due to the fact that it filled a gap in the literature regarding the security aspect of the internet of things, which is a critical issue in the field of health. The most cited articles were all published between 2011 and 2017, and they addressed current themes including the internet of things, security, data mining, and machine learning. This finding confirms the previous research finding. Considering the study's time frame as a limitation, it is important to remember that the number of citations will alter as well.

Within the constraints of some limitations, the research reveals the present state of the cyber security field and research trends. In this regard, the study is limited to the publications cyber security published between 1998 and 2021 and found in the WoS database and whose abstracts include the terms cyber security, cyber-security, or cyber security. Therefore, it is recommended that the database and document type in future research be expanded. Although WoS is considered the most effective tool for bibliometric analysis (Alnajem, 2021), working with a single database may have missed some important research on cyber security. In order to better understand the studies carried out, other types of documents can be included in the research and a systematic literature review can be conducted to strengthen and improve the findings of this research. The study is limited to co-citation analysis and co-word analysis in terms of bibliometric analysis. Therefore, it will be beneficial for the field to examine and support the studies conducted in the field of cyber security qualitatively.

Due to the increasing attacks and threats in cyberspace, the security of not only institutions but also personal data has gained extra importance. Although there is increasing interest in the field of cyber security, there is still a need to address relevant research gaps. Although most current research deals with the different sub-dimensions of cybersecurity, the overall state of the cybersecurity field remains completely unexplored. Therefore, there is a work gap in this area. In this study, first of all, the performance status and intellectual status of the cyber security field have been revealed in order to help researchers who want to do research in the field of cyber security. So this study is designed to be implemented in the first phase of the development of a new study. According to the results of the study, researchers can investigate the reasons for this situation (not mentioned in the article) by examining how many articles were produced in which years. In addition, by taking into account the

performance status of the journals, they can examine the journal that has the most publications on cyber security. They can even review these journals first to submit their publications. In our study, the most frequently used words by the authors and the relationship of these words with each other were revealed, and the trends of the field were revealed. By taking these words into account, researchers can choose research topics that dominate the field and determine which subtopics they can work with. Considering the result of the study, the issue of how security is ensured, especially in the Internet of Things, can be examined. The result of this study may enable the relevant references of the literature to be taken into account for the construction of new studies. Researchers can access the most cited articles and start the literature search from these articles. In the study, author collaboration, which is one of the factors that will reveal the intellectual state, was not mentioned. Researchers can reflect social ties by revealing the relationship and social networks between authors with co-author analysis. The enhanced understanding of science through bibliometric analysis can facilitate knowledge creation.

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