Kocaeli Üniversitesi Eğitim Dergisi
E-ISSN: 2636-8846
2023 | Cilt 6 | Sayı 2
Sayfa: 374-394

Kocaeli University Journal of Education
E-ISSN: 2636-8846
2023 | Volume 6 | Issue 2
Page: 374-394

Problem çözmeye yönelik öz-yeterlik ölçeği geliştirme çalışması

A study of developing a scale of problem-solving self-efficacy

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Bu çalışma, Yasemin KATRANCI danışmanlığında, Büşra KIRAL tarafından hazırlanan "Problem çözmeye yönelik öz-yeterlik ölçeği geliştirilmesi ve değerlendirilmesi" başlıklı yüksek lisans tezinden üretilmiştir.

ARAŞTIRMA MAKALESİ

Gönderim Tarihi	Düzeltme Tarihi	Kabul Tarihi
20 Aralık 2022	*12 Haziran 2023*	*21 Temmuz 2023*

Önerilen Atıf

Recommended Citation

Kıral-Demir, B., & Katrancı, Y. (2023). Problem çözmeye yönelik öz-yeterlik ölçeği geliştirme çalışması. *Kocaeli Üniversitesi Eğitim Dergisi, 6*(2), 374-394. http://doi.org/10.33400/kuje.1221777

ÖZ

Eğitimin temel amacı, insanların düşünmelerini ve zihinsel güçlerini kullanarak daha iyi birer problem çözücü olmalarını sağlamaktır. Bunun için bilişsel faktörlerin yanı sıra duyuşsal faktörlerin de dikkate alınması gerektiğine inanılmaktadır. Bu duyuşsal faktörlerden biri öz-yeterlik olarak kabul edilir. Öz-yeterlik, bireylerin bir görevi yapma ve gerekli etkinlikleri düzenleyerek başarılı olma becerileri hakkındaki yargıları olarak ifade edilmektedir. Problem çözme öz-yeterliliği ise, kişinin problem durumlarıyla sabırla başa çıkabileceğine ilişkin kendi yeterliliğine olan inancı olarak tanımlanmaktadır. Buna göre bu çalışmada, problem çözme öz-yeterliğini belirlemek için bir ölçeğin geliştirilmesi amaçlamıştır. Bu amaçla ölçek geliştirme aşamaları takip edilmiştir. Ölçeğin geliştirilmesi ve geçerliğinin sağlanması için Türkiye'deki devlet ortaokullarında sekizinci sınıfta öğrenim gören 422 öğrenciden veri toplanmıştır. Ölçeğin faktör yapısını belirlemek için açımlayıcı faktör analizi, ortaya çıkan yapıyı test etmek için doğrulayıcı faktör analizi gerçekleştirilmiştir. Ayrıca ölçek maddelerinin madde analizi yapılmıştır. Açımlayıcı faktör analizi sonucunda ölçeğin iki faktöre sahip olduğu görülmüştür. Bununla birlikte doğrulayıcı faktör analizine göre tüm değerlerin iyi veya mükemmel uyum sağladığı belirlenmiştir. Tüm ölçeğin Cronbach alfa iç tutarlılık katsayısı 0.91; alt faktörler için güvenirlik katsayıları sırasıyla 0.88 ve 0.87'dir. Bu sonuçlar ölçeğin güvenirliğinin yüksek olduğunu göstermektedir. Sonuçta, problem çözme öz-yeterliğini belirlemede kullanılabilecek geçerliği ve güvenilirliği yüksek bir ölçek geliştirilmiştir. Literatürdeki araştırmalar, öğrencilerin öz-yeterliklerinin problem çözme becerileriyle ilişkili olduğunu göstermektedir. Bu sebeple, geçerliği ve güvenilirliği kanıtlanmış problem çözme öz-yeterlik ölçeğinin öğrencilere uygulanmasıyla elde edilen sonuçların bazı demografik faktörler dikkate alınarak incelenmesi önerilmektedir.

Anahtar Sözcükler: problem çözme, öz-yeterlik, ölçek geliştirme, geçerlik, güvenirlik

ABSTRACT

The primary goal of education is to help people become better problem solvers by utilizing their thinking and mental abilities. As a result, affective factors should be considered in addition to cognitive factors. Self-efficacy is one of these affective factors. Self-efficacy refers to people's beliefs about their skills to perform a task and succeed by organizing necessary activities. In this case, problem-solving self-efficacy is defined as one's belief in one's own ability to deal with problems patiently. In this study, we aimed to develop a scale to measure problem-solving self-efficacies. The study was executed according to scale development stages. Data were collected from 422 eighth-grade students in Turkey's public middle schools to develop and validate the scale. Exploratory factor analysis was used to determine the scale's factor structure and confirmatory factor analysis was performed to test the resulting structure. In addition, item analysis of the scale items was executed. As a result of the exploratory factor analysis, it was seen that the scale had two factors. However, according to the confirmatory factor analysis, it was determined that all values provided a good or perfect fit. Furthermore, Cronbach's alpha coefficient for the entire scale was 0.91; for subfactors, 0.88 and 0.87, respectively, indicating that the scale is highly reliable. A high validity and reliability scale was eventually developed to determine problem-solving self-efficacy. Studies in the literature show that students' self-efficacy is related to their problem-solving skills. Therefore, we propose additional research to investigate the developed scale's effect on students while considering demographic factors.

Keywords: problem-solving, self-efficacy, scale development, validity, reliability

INTRODUCTION

Doing math is not about doing many exercises or imitating the methods explained by the teacher but developing a method to solve a problem in the real sense, applying these methods, and evaluating whether it leads to results (Van de Walle et al., 2019). It is possible to say that learning mathematics in this situation is the same as internalizing problem-solving. Education makes people better problem-solvers by encouraging them to think and use their mental abilities (Gagne, 1980). Developing problem-solving skills is a broad issue for education because one of the main goals of all education systems is to contribute to the development of students' ability to solve individual and social problems (Mayer, 1999). This is accomplished through effective mathematics education. Students who receive an effective mathematics education solve and discuss problems that foster their ability to reason mathematically and solve problems in a variety of ways (National Council of Teachers of Mathematics [NCTM], 2020). Individuals are expected to solve problems on their own and make decisions based on their reasoning as they mature. This independent problem-solving is also regarded as an indicator of an individual's adaptability. A person cannot maintain their integrity as an independent personality unless they resolve their own issues (Bloom et al., 1956). As a result, a competency that the education system expects from everyone is problem-solving skills for both personal and social harmony.

According to the NCTM (2000) standards, problem-solving is more than just a goal for other learning. Within the framework of these standards, curricula from preschool to twelfth grade should ensure that all students acquire the following problem-solving skills:

1. Creating new mathematical situations through problem-solving,
2. Solving problems that occur in mathematics and in all other situations,
3. Using and adapting various appropriate problem-solving strategies,
4. Reflecting on the mathematical problem-solving process by controlling (NCTM, 2000).

It may be argued from this perspective that pupils who develop problem-solving skills would not have difficulty doing mathematics. Getting children to believe they can solve problems and giving them the confidence to do so is a requirement for improving their problem-solving abilities. Thus, it is predicted that students who feel competent in problem-solving will generally feel competent in mathematics lessons. The research (Altunçekiç et al., 2005; Chen, 2005; Hoffman & Schraw, 2009; Kesgin, 2006; Yenice, 2012) shows that self-efficacy enhances problem-solving performance. Self-efficacy, according to Pajares and Kranzler (1995), influences students' decisions, efforts, and perseverance despite challenges, emotional responses, and thought processes. As a result, they contend, having high self-efficacy may benefit students when they tackle math problems. They defend this by not claiming that students' increased self-efficacy will "cause" them to be better problem-solvers but rather that it will lead to increased interest, determination, effort, and attention. In this context, it is thought that it is necessary to investigate how competent students feel in problem-solving. However, there are currently only a limited number of tools evaluated students' problem-solving self-efficacies.

In order to measure high school students' self-efficacy in solving mathematical problems, Pajares and Kranzler (1995) modified the mathematics confidence scale created by Dowling (1978) based on prior research. The five-point Likert-type scale was extended to a six-point scale to measure self-efficacy. The Cronbach's alpha (CA) score was calculated as 0.92. In conclusion, they determined that high school students' self-efficacy in mathematical problem-solving had strong direct effects on math anxiety and math problem-solving performance, even when controlling for general mental ability. Additionally, they discovered that although students' math anxiety was significantly related to their problem-solving abilities, this relationship was ultimately the product of non-causal covariation, mostly because of the influence of self-efficacy.

To establish the relationship between fifth-grade students' attitudes toward mathematics, their success, and problem-solving self-efficacy, Nicolaidou and Philippou (2003) devised and used a problem-solving self-efficacy scale. The scale has a Likert-type of five point and the CA score is 0.93. As a result, they discovered that pupils who had a favorable attitude toward mathematics

believed in themselves more and had greater success in a particular discipline. Additionally, they discovered that self-efficacy for problem-solving had a better predictive capacity than attitude toward mathematics. Self-efficacy is effective in problem-solving and that it is a situation that needs measurement according to the research findings. Zimmerman (2000) notes that self-efficacy is responsive to changes in students' learning strategies and predicts positive outcomes when used as a mediating variable in educational studies. In addition to self-efficacy scales for problem-solving, for mathematics education, a scale for problem-posing self-efficacy (Özgen & Bayram, 2019), mathematics teaching self-efficacy (Gerez-Cantimer et al., 2020; Göloğlu-Demir & Çetin, 2010), problem-oriented mathematical creativity self-efficacy (Aksungur-Altun & Açıkgül, 2022), mathematical creativity self- efficacy (Açıkgül & Aksungur-Altun, 2022), and middle school mathematics self-efficacy resources have also been developed (Usher & Pajares, 2009). There are similarities and differences between the scales developed in these studies and the scale in our study. Since each is a self-efficacy scale development study, the items related to the feature to be measured are similar, although the purpose they want to measure varies. For example, in Özgen and Bayram's (2019) problem-posing self-efficacy scale development study, the item "I cannot write problems that can be solved in more than one way." shows similarities with the item "I can solve a mathematical problem in more than one way." in terms of containing problems that can be solved in more than one way. However, one of them is the items prepared to measure self-efficacy related to problem-posing and the other to solving. Similarly, the item “I can find original solutions to the mathematical problems I encounter in daily life.” in the mathematical creativity self-efficacy scale development study of Açıkgül and Aksungur-Altun (2022) and the item “I can develop a strategy to solve a mathematical problem.” in our study are prepared to determine the self-efficacy of the individual to find a unique solution regarding the solution of a mathematical problem situation. However, while Açıkgül and Aksungur-Altun (2022) wanted to measure an individual's mathematical creativity self-efficacy with this item, in our study, this item was used to determine the individual's problem-solving self-efficacy. These studies were developed to determine individuals' self-efficacies in different age groups for skills that need to be developed in mathematics education. In this situation, the necessity of self-efficacy studies in mathematics education is stressed.

Research (Nicolaidou & Philippou, 2003; Pajares & Kranzler, 1995) shows that two scales were developed to determine the problem-solving self-efficacy of high school and middle school fifth grade students. This research includes students studying in different cultures and times. Given how self-efficacy affects problem-solving success, it is necessary to develop a self-efficacy scale for middle school students that considers the curriculum's shifting objectives, skills (self-regulation skills, affective characteristics, basic skills, psychomotor skills), and problem-solving approaches. As a result, there is a need for accurate and reliable scales that can be used to measure students' problem-solving self-efficacies. For this reason, there is a need for scales that are valid and reliable and that are developed by considering the stages of self-efficacy scale development to disclose students' self-efficacy in problem-solving. As a result, the goal of this study is to create a measurement tool that can be used to measure self-efficacy for problem-solving. Accordingly, a more effective learning process should be designed using specific teaching methods to improve the students' academic success considering the results acquired after using the scale.

REVIEW OF LITERATURE

Problem-Solving

The problem is a situation where no ready-made procedure exists for enabling someone to achieve their intended outcome. Even though an effective procedure might be created or remembered in the end, this procedure does not exist at the time of the problem. Therefore, a person should create their own procedure or gain access to an already improved one. Problem-solving is the general term for defining this process (Mayer, 1999). Thus, one definition of problem-solving could be the process of making something the way one wants it to be, that is, transforming "what is" into "what should be" (VanGundy, 2005). Problem-solving is a practical

skill, like swimming. Practical skills are gained through imitation and practice. Swimming is learned by imitating what other people do to keep their heads above the water while swimming and by practicing it. Problem-solving is learned by observing and imitating what other people do while solving problems. Ultimately, problem-solving is learned through solving problems (Polya, 2017). According to Polya (1945), there are four steps in solving a mathematical problem. The following are these phases:

1. Understanding the problem,
2. Creating a plan to solve the issue,
3. Putting the plan into action,
4. Verifying the accuracy of the outcome.

The skill to solve problems is the most fundamental skill required for humans to survive. Since it is impossible to predict the difficulties that individuals and society will face, when those difficulties occur, and what they will need, modern education tries to develop people capable of overcoming those challenges independently. Furthermore, solving problems requires more than knowledge (Altun, 2014). Considering these definitions, it is possible to infer that problem-solving is a process that uses past experiences to eliminate a problem that has not been encountered before. People should develop their problem-solving skills to benefit from these experiences. According to Charles et al. (1987), solving problems requires the connection of various skills, attitudes, intuitions, beliefs, knowledge, and achievements. Students' perceptions of what they can do significantly impact and predict academic development (Pajares, 1996). In this context, self-efficacy is a circumstance that pupils may be impacted by. According to Nijhuis et al. (2005), students frequently have difficulties with their self-efficacy in organizing and solving problems.

Self-Efficacy

People's judgments of their skills to perform a task and succeed by planning necessary activities are referred to as self-efficacy (Bandura, 1997; Zimmerman, 1995). Gawith (1995) associates self-confidence with self-efficacy and stated that even if a person has the skills to complete a task, they are unable to do so if they lack the self-confidence to carry it out. Once initiated, self-efficacy influences individuals' coping efforts by reducing their fears, inhibitions, and expectations of ultimate success. Self-efficacy decides how much effort people put into overcoming obstacles and how long they can persist when facing discouraging experiences. The more active they are in their efforts, the higher their self-efficacy will be. Those who insist on comparatively safe and subjectively threatening activities will benefit from corrective experiences that boost their sense of efficacy, ultimately eradicating their fear and defensiveness. Early quitters will hold onto their waning expectations and fears for a long time (Bandura, 1977). Additionally, according to Skaalvik et al. (2015), self-efficacy is a powerful predictor of students' motivation. Self-efficacy enables people to exert control over certain circumstances and produce beneficial outcomes (Geitz et al., 2016). In this sense, every initiative to improve students' academic performance should be planned with their self-efficacy in mind. Hoffman and Spatariu (2008) assert that self-efficacy is the best predictor of academic development and cognitive engagement. Perseverance and effort that come with self-efficacy play a key part in solving mathematical problems (Lopez et al., 1997; Pajares & Kranzler, 1995; Pajares & Miller, 1994).

Problem-Solving Self-Efficacy

Bandura (2006) defined problem-solving self-efficacy as the belief that one can successfully handle problems. Based on the definitions of problem-solving and self-efficacy, one's belief in their ability to cope with problem situations patiently could be described as problem-solving self-efficacy. Pajares and Kranzler (1995) state that improving the calibration of students requires helping them to better understand what they know and what they do not know so that they can apply appropriate cognitive strategies more effectively in the problem-solving process; however, the challenge is to achieve this without lowering their confidence and optimism. Therefore, in addition to providing students with problem-solving skills, they should also be assisted in growing

their sense of self-efficacy. Hoffman and Schraw (2009) link students' self-efficacies to the tactics they will use when solving problems. According to Fitriani et al. (2020), self-efficacy and cognitive intelligence are necessary for problem-solving. Additionally, self-efficacy in problem-solving might influence a student's drive to overcome difficulties in academic settings (Bandura, 2006). Hoffman and Spatariu (2008) state that one of the strongest beliefs about success in problem-solving is the individual's self-efficacy. According to studies, self-efficacy makes a strong contribution to the prediction of problem-solving as well as general mental ability, and it is a powerful determinant and predictor of academic results (Pajares & Kranzler, 1995; Pajares & Miller, 1994). Hoffman and Spatariu (2008) found that students with higher self-efficacy solve more problems accurately and efficiently, regardless of orientation. Similarly, some studies (Schoenfeld, 2013; Ulandari et al., 2019) report that students' beliefs about themselves and problem-solving will affect their problem-solving success.

METHOD

The scale development methodology included several steps. First, a literature review was conducted to create a draft scale on self-efficacy for problem-solving. Then, it was decided to consider problem-solving stages, dimensions of self-efficacy, scale development studies for problem-solving self-efficacy, and problem-posing self-efficacy scale development studies in writing scale items. Problem-solving has four stages: understanding the problem, creating a plan to solve the issue, putting the plan into action, and verifying the accuracy of the outcome (Polya, 1945). In this context, while creating the self-efficacy scale items for problem-solving, these four stages of problem-solving, self-efficacy experiences gained (success and failure), observational experiences (success of others), persuasion process (confirmation of the individual's environment), and affective processes (anxiety, excitement, etc.) (Bandura, 1995) were considered. In addition, along with the literature on problem-solving self-efficacy (Dowling, 1978; Nicolaidou & Philippou, 2003; Pajares & Kranzler, 1995), the problem-posing self-efficacy scale developed by Özgen and Bayram (2019) was used as a source. For writing the items of the developed scale, considering that there is an essential relationship between problem-solving and problem-posing self-efficacy. In this context, the study initially consisted of 61 items. An example of the items created for each stage of problem-solving is as follows: "I understand problems, but usually I cannot solve them." (understanding the problem), "I can develop a strategy to solve the problem." (creating a plan to solve the issue), "I can find the steps needed to solve a problem." (putting the plan into action), and "After solving the problems, I check the correctness and correct my mistakes if any." (verifying the accuracy of the outcome). An example of the items prepared for the four dimensions of self-efficacy is as follows: "I am successful in solving problems." (experiences gained), "When I solve math problems incorrectly, my confidence in math decreases." (affective processes), "I find myself inadequate in solving problems compared to my classmates." (observational experiences), and "When people around me say that I am good at solving problems, it increases my belief that I can solve problems." (persuasion process). Examples of items similar to the scales in the literature used in article writing: While an item in Nicolaidou and Philippou's (2003) scale is "I usually can help my classmates when they ask me for help in problem-solving.", the item "I can help my friends who have problems in solving problems." is included in the scale that we developed. Pajares and Kranzler (1995) stated in their research that Dowling's (1978) mathematics confidence scale was used to determine the problem-solving self-efficacy of high school students. The item "I get a sinking feeling when I think of trying hard math problems." in Dowling's (1978) math confidence scale item and the item "I can solve a difficult mathematical problem by struggling." in our scale are similar in content. The item "I cannot write problems that can be solved in more than one way." in Özgen and Bayram's (2019) problem-posing self-efficacy scale development study and the item "I can solve a math problem in more than one way." in our scale item contain problems that can be solved in more than one way. The students' ages and grade levels were also considered when creating the item pool. Considering the description of problem-solving and self-efficacy, the researchers created an item pool of 61 items considering the relevant literature. The created item pool was examined

with three middle school mathematics teachers. Some items in the item pool have been edited to make them clearer and more understandable. For example, the "I cannot solve problems without help from others." item was rephrased as "I cannot solve problems without help from those around me (family, teachers, friends, etc.)". Some items were completely removed from the item pool due to reasons such as inconsistency with the concept that the scale wanted to measure or expressing the same situation with another item. For example, "I want to be as good at problem-solving as my math teacher", "I am afraid of math problems", and "I think problem-solving is fun." items have been removed. As a result, a new item pool of 43 items was prepared.

Subsequently, the prepared item pool was re-examined with an expert with a doctorate in mathematics education and two middle school mathematics teachers different from those in the first examination. The study replaced "problem" expressions with "mathematics problem" expressions to prevent possible confusion. Some items were excluded from the item pool; considering that items such as "I can visualize the stages of problem-solving (understanding, planning, applying, and evaluating) while solving a problem.", "I have difficulty solving verbal/story problems in mathematics." are not suitable for middle school students, and items that are not aligned with the concepts regarding the scale wanted to measure, such as "I can use my creative skills in solving math problems.". Since the item "I can solve a problem most understandably and shortly." contains more than one judgment, two separate items were formed as follows; "I can solve a mathematical problem most understandably." and "I can solve a math problem most shortly.". As a result, a 39-item draft scale was developed. 26 of the scale items are positive and 13 are negative.

Afterwards, the items were arranged according to the three-level expert opinion form as "appropriate", "partially suitable", and "not suitable". In addition, a "suggestions" section has been added for experts to express their opinions when necessary. Five expert mathematics educators examined the prepared expert opinion form. After receiving expert opinions, the forms were examined, and items with similar expressions, which were not thought to measure self-efficacy for problem-solving and could not be agreed upon, were removed from the scale. Content validity indicates whether the items that make up the scale are sufficient in quality and quantity for measuring behavior (self-efficacy for problem-solving). Another way to determine content validity is to obtain expert opinion (Büyüköztürk, 2018). At this point, as explained above, the scale was subjected to expert opinions thrice. In this regard, content validity was also ensured. Finally, a 32-item draft scale was prepared. Gender information was added as demographic information before the scale was applied. Thus, it was made ready for implementation.

Participants and Data Collection

The problem-solving self-efficacy scale (PSSES) was applied to 430 eighth-grade students studying at five public middle schools in Türkiye. The study group was selected according to the convenient/accidental sampling method. In this method, the researcher creates a sample from the most accessible and appropriate respondents until reaching the required number of groups (Ravid, 2010). The presence of any unanswered statements on the scales was checked before the data were analyzed. The evaluation excluded eight scales that were left unanswered or incomplete questionnaires. Therefore, we decided to perform analyzes with the data obtained from the remaining 422 data collection tools. If the sample size is sufficient, it is advised in scale development studies to divide the sample into two groups at random and then analyze the data using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) on the information from the two different samples (Fabrigar et al., 1999). In this regard, the data obtained were randomly divided into two groups. While EFA and item analysis were performed with the data obtained from the first group (211; 98 girls, 113 boys), CFA was performed with the data obtained from the second group (211; 119 girls, 92 boys). Reliability analyzes were performed using the data obtained from both groups.

The data were obtained face-to-face from middle schools in the fall semester of the 2020-2021 academic year. The participation of the students in the research was on a voluntary basis. Since

the students were under 18, consent forms were obtained from the parents of all study participants. Before the final application of the scale, we determined that it took approximately 20 min to be answered by applying it to five students in the 8th grade. Therefore, students were allowed 30 min to apply the final scale.

Data Analysis

Validity is a concept related to how accurately the scale measures the characteristic of the individual to be measured (Büyüköztürk, 2018). Therefore, a scale development study should test content and construct validity. Regarding this, content validity has been explained above. Construct validity, on the other hand, is the degree to which a scale can accurately measure a concept to be measured. Factor analysis, cluster analysis, or hypothesis testing techniques can be used to test this validity (Büyüköztürk, 2018). Therefore, exploratory and confirmatory factor analyzes for construct validity were performed in this study. In addition, the CA reliability analysis was performed to determine the scale's internal consistency. SPSS 25 and LISREL 8.7 package programs were used in the analysis, and the significance levels were 0.05 and 0.01 for item analysis.

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 title of "Actions Contrary to Scientific Research and Publication Ethics," which is the second part of the directive, were not carried out.

Scientific, ethical, and citation rules were followed in this study's writing process; no changes were made to the collected data, the participants officially accepted to participate, and this study was not sent to any other academic publication medium for evaluation.

Before the research, a permission document approved by the Governor's Office and the Provincial Directorate of National Education was obtained so that the application could be carried out in official middle schools (dated 29.09.2020 and numbered 99332089/605.01/13743466). In addition, participation in the research was conducted based on the voluntariness of the students, and the parent permission petition forms were obtained from the parents of the students.

Research ethics committee approval information

The committee involved in ethics evaluation: Science and Engineering Sciences Ethics Committee of Kocaeli University

The date of ethics evaluation: 05.03.2020 and 2020/04

The serial number of the document of ethics evaluation: 10017888-100/E.21089

RESULTS

Is the PSSES Valid?

Before starting the analysis procedures, reverse coding was done for negative items. The purpose of factor analysis in scale development studies in social sciences is to discover which variables in a single data set are consistent with subsets relatively independently of another variable, to reveal the construct validity, and to determine the factor structure of the measurement tool (Çokluk et al., 2018; Tabachnick & Fidell, 2015). The first thing to consider before factor analysis is the sample size. Bryman and Kramer (2001) interpreted the sample size as five or ten times the numbers of items on the scale. According to Çokluk et al. (2018), twice the number of items in the scale is sufficient. In this regard, EFA procedures in this study were carried out on a sample of 211 people, and it was considered sufficient because the number of items was more than six times.

The result of the Kaiser-Meyer-Olkin (KMO) test, which determines the suitability of the dataset for factor analysis in the context of sample size, is another situation that needs attention. The KMO value 0.80 is "very good"; 0.90 is "perfect" (Leech et al., 2005; Şencan, 2005; Tavşancıl, 2005). Another consideration is to examine whether the data are normally distributed. The Barlett Test (BT) is performed for this situation. BT determines whether there is a high correlation between some or all the variables in the correlation matrix; the larger the result, the more likely it is to be significant, and if the significance value is greater than 0.05, factor analysis cannot be performed for the dataset in question (Şencan, 2005). Table 1 shows the results of these tests.

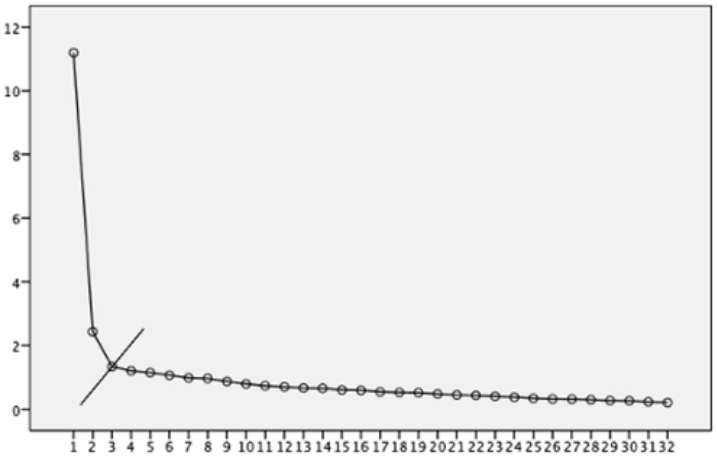
Table 1
KMO and BT Results of PSSES

KMO		0.88
BT	X^2	1134.62
	sd	105
	p	0.00*

p<0.05*

When Table 1 is examined, it is concluded that the KMO value calculated for the research is 0.88; thus, the analysis continues. In addition, the result of BT (X^2=1134.62; p<0.05) showed that EFA could be performed. Therefore, because of the evaluations, EFA was carried out. Principal component analysis was used to determine the factor pattern of PSSES, and maximum variability (varimax) was determined as the rotation method from the vertical rotation method as the factorization method. Two factors with an eigenvalue greater than "1" were obtained in determining the number of factors. Büyüköztürk (2018) states that the high-accelerated and rapid declines in the scree plot indicate the number of important factors, while the horizontal lines indicate that the contribution of explaining the variance is close to each other. Figure 1 shows the scree plot of PSSES.

Figure 1
Scree Plot of PSSES



Regarding Figure 1, it is seen that the graph follows a horizontal course after the second factor. As a result, it was deemed appropriate to have two factors on the scale. After determining the number of factors, attention should be paid to the load values of the factors. Factor loading values are coefficients that explain the relationship between items and factors (Kline, 1994). Tabachnick and Fidell (2015) state that factor loading values should be 0.32 and above to explain 10.00% of the variance. Therefore, the analysis procedures in this study were employed based on this. The varimax technique was used to name and interpret the two factors obtained. With the varimax technique, a rotated component matrix is created with rotation applied to the factor matrix (component matrix), showing the factor loading values of the items. At the end of the rotation

process, while the load of the items on one-factor increases, the load on the other decreases so that the factors can be easily interpreted.

When interpreting the factor loading values in the rotated factor matrix, the most important issue is whether the factor loading values meet the acceptance level and determine the overlap. The overlap of an item occurs first when more than one factor gives a higher value than the acceptance level and second when the difference between the load values of the item in two or more factors is less than 0.1. Before determining whether they met the acceptability level, the overlap of factor loading values was examined. In this situation, 12 items were initially eliminated from the scale. Five additional items were eliminated from the scale following the reliability analysis. As a result, 15 items in two factors remained on the scale. Finally, the final scale consisting of 15 items is presented in Appendix-1. Table 2 contains the results of the EFA of the scale.

Table 2
PSSES-EFA

Item No	F1	Item No	F2
01	.63	03	.39**
02	.49**	06	.78
04	.72	07	.82*
05	.56	08	.82*
11	.74*	09	.63
12	.64	10	.74
13	.56		
14	.68		
15	.72		

**Max value, ** Min value, Total variance explained = 49.58%*

When Table 2 was examined, it was determined that the factor loading values of the items under the first factor varied between 0.49 and 0.74. Since the items under the first factor generally express students' positive behaviors, feelings, and thoughts about problem-solving, it was named "positive self-efficacy for problem-solving (F1)". On the other hand, it was determined that the factor loading values of the items under the second factor varied between 0.39 and 0.82. Since the items under the second factor generally express the student's negative behaviors, feelings, and thoughts about problem-solving, the second factor was named "negative self-efficacy for problem-solving (F2)". In addition, the contributions of the factors to the total variance were 26.66% from the first factor and 22.91% from the second factor. As a result, the total contribution of the two factors to the variance was calculated as 49.58%.

After the EFA portion, item analysis was performed to determine whether the outcomes of applying the items to the selected criterion were compatible and if not, to determine the potential causes for this condition and to ensure that they served the intended purpose. Item analyzes were performed for the whole scale and each subfactor separately. While conducting the item analysis of the research, the Item-Total Correlation (ITC) and the Item-Remainder Correlation (IRC) were performed based on the 0.01 significance level. ITC shows the relationship between the total score of the test and the scores obtained from the test items (Büyüköztürk, 2018). A high and positive ITC indicates that the items exemplify similar situations, and that the test's internal consistency is also high. ITC is determined using the Pearson Product-Moments Correlation coefficient in a test with Likert-type scales. Büyüköztürk (2018) states that items with IRC of 0.30 and higher are distinguishable at a good level.

IRC is the relationship of an item with the total score obtained from other items (Terzi, 2017). Therefore, the number of relationships obtained from IRC should be higher than the correlation coefficient obtained from ITC. Table 3 contains the findings obtained.

Table 3
PSSES-ITC-IRC

Factors	Item No	ITC	IRC
F1	01	0.57	0.64
	02	0.38**	0.46**
	04	0.56	0.63
	05	0.52	0.59
	11	0.46	0.55
	12	0.44	0.52
	13	0.48	0.56
	14	0.62*	0.68*
	15	0.52	0.60
F2	03	0.40	0.49
	06	0.59	0.66
	07	0.53	0.62
	08	0.51	0.60
	09	0.55	0.63
	10	0.52	0.61

**Max value **Min value*

ITC and IRC values for the entire scale were significant at the 0.01 level, as shown in Table 3. Table 4 shows the conclusions on the connections between the scale's subfactors and the overall.

Table 4
Correlations between the Scale and its Subfactors

	F1	F2	PSSES
F1	1	0.45	0.87
F2		1	0.82
PSSES			1

p<0.01*

Table 4 shows that the correlation between F1 and F2 was 0.45, whereas the correlation between F1 and the entire scale was 0.87 and the correlation between F2 and the entire scale was 0.82. CFA was used to validate the 15-item scale obtained using EFA. CFA assesses the measurement instrument construct validity (Kline, 2005). Table 5 shows the conclusions reached because of CFA.

Table 5
PSSES-CFA

Indices	X^2/sd	RMSEA	NFI	NNFI	CFI	RMR	SRMR
Value	1.84	0.06	0.96	0.98	0.98	0.06	0.05

As seen in Table 5, 1.84 was found for X^2/sd ratio of PSSES; 0.06 for RMSEA; 0.96 for NFI; 0.98 for NNFI; 0.98 for CFI; 0.06 for RMR, and 0.05 for SRMR because of the analyzes. Each observed variable is included only under its latent variable when displaying figures and symbols with the road diagram (Kline, 2005). Figure 2 shows the CFA graph of PSSES' indicators obtained from two factors and 15 items.

Figure 2
CFA Graph of PSSES

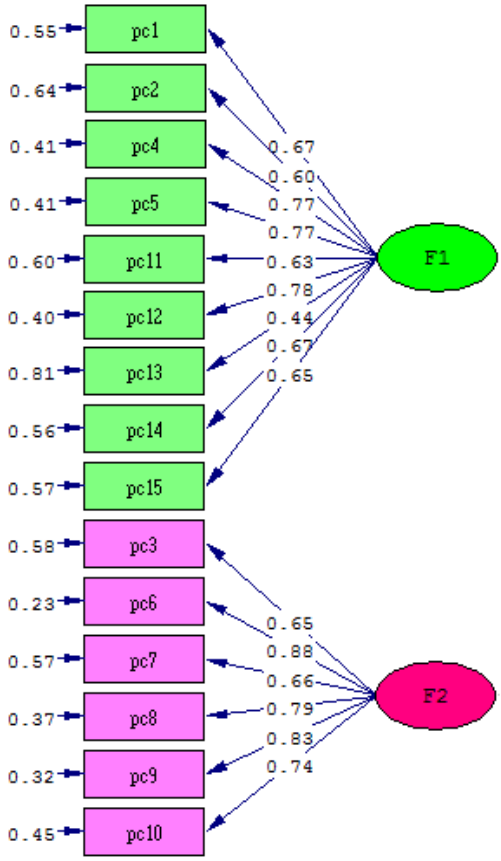


Figure 2 illustrates that the t-values of the items under F1 and F2 range from 0.40 to 0.81 and 0.23 to 0.58, respectively. Error variance shows the part of the data set that cannot be explained (Büyüköztürk, 2002). Therefore, error variances should be less than 1 (Gürbüz & Şahin, 2016). After all, the study has no error variable because all error variances are less than 1.

Is PSSES Reliable?

Reliability analysis is a method developed to examine the characteristics and reliability of tests, scales, or questionnaires. For the reliability analysis in the research, the CA reliability of the 32-item draft scale was first calculated. Then, after the EFA, 17 items were discarded, and reliability analyzes were performed for all the remaining 15 items and then for their subfactors. Table 6 includes the calculated reliability coefficients.

Table 6
CA Reliability Coefficients of PSSES

		CA
EFA	F1	0.84
	F2	0.82
	Total	0.86
CFA	F1	0.88
	F2	0.87
	Total	0.91

According to Table 6, the CA for the entire scale was 0.91. Similarly, F1 had CA value of 0.88 and F2 had CA value of 0.87.

CONCLUSION and DISCUSSION

The scale in the scale development study initially turned out to have a two-factor structure. These factors are positive self-efficacy for problem-solving and negative self-efficacy for problem-solving. The Mathematics Confidence Scale developed by Dowling (1978) was adapted by extending 5-point Likert items to 6-points to measure the Problem-Solving Self-Efficacy of High School Students by Pajares and Kranzler (1995). The adapted version of Pajares and Kranzler's (1995) scale consisted of eight subdimensions, which involved three elements of mathematics (arithmetic, algebra, and geometry), three cognitive levels (computation, comprehension, and application), and two perspectives of problems (real and abstract). The tool developed by Nicolaidou and Philippou (2003) has a one-dimensional structure.

When we consider mathematics anxiety scales as an example of scale development studies in mathematics education, while there is only one factor in the scale developed by Bindak (2005), there are four factors in the scale developed by Erktin et al. (2006), and two factors in the scale developed by Bai et al. (2009) and adapted into Turkish by Akçakın et al. (2015). Therefore, as the scale development studies for math anxiety continued, different dimensions were revealed. It was thought that these dimensions that emerged in affective characteristics might also be valid for problem-solving self-efficacy.

There are nine items under F1 on this scale with two factors. As a result, the variance rate explained by F1 was calculated as 26.66%. There are six items under F2; consequently, the variance rate explained is 22.91% by F2. In this regard, the total variance rate explained by the scale is 49.58%. Researchers considered that the variance rate explained in the social sciences is between 40-60% (Scherer et al., 1988). Therefore, the contribution of a defining factor in the developed scale to the total variance could be considered sufficient.

Second, it has been determined that the items in the scale are sufficiently distinctive, have high validity, and measure the same structure. Correlations between the scale subfactors and the relationship between the subfactors and the whole scale were examined. The correlation value obtained for F1 and the whole scale was 0.87, and the correlation value between F2 and the whole scale was calculated as 0.82. A correlation between 0.70 and 1.00 indicates a high level and a correlation coefficient between 0.30-0.70 means a medium level of correlation (Büyüköztürk, 2018). Therefore, the correlation coefficients obtained in this study show a high level of correlation. The correlation value between F1 and F2 was calculated as 0.45 and it was found that there was a moderate correlation between them. This level of relationship between subfactors is desirable. Because the high correlation between the subfactors (0.60 and above) causes the factors to be interdependent and not evaluated as separate subscales (Engs, 1996), the moderate relationship between the subfactors of the scale developed in this study indicates that the subfactors are independent within themselves and is also proof of the desired situation.

Third, CFA procedures were performed. An X^2/sd ratio equal to or less than 2.50 in CFA indicates a perfect fit (Kline, 2005). In this study, the X^2/sd ratio was calculated as 1.84 and it was seen that a perfect fit was achieved. A RMSEA value equal or less than 0.06 indicates a good fit (Thompson, 2004). The RMSEA value determined in this research provides a good fit of 0.06. NFI, NNFI, and CFI values equal or greater than 0.95 indicate a perfect fit (Sümer, 2000; Tabachnick & Fidell, 2015). In this research, it was determined that the perfect fit was achieved with an NFI value of 0.96, NNFI value of 0.98, and CFI value of 0.98. RMR and SRMR values less than or equal to 0.05 mean perfect fit, and values less than or equal to 0.08 mean good fit (Brown, 2006). In this research, the RMR value is 0.06 and the SRMR value is 0.05, it was determined that they provided a good and perfect fit.

Fourth, reliability analyzes were carried out. The CA values of the whole scale were calculated as 0.91 and the CA values of F1 and F2 were calculated as 0.88 and 0.87, respectively. Pajares and Kranzler (1995) calculated a CA value of 0.92 for Dowling's (1978) expanded scale to determine high school students' problem-solving self-efficacies. Nicolaidou and Philippou (2003) calculated the CA value of the mathematics self-efficacy tool for the problem-solving performance they

developed as 0.93. Kalaycı (2016) states that the scale's reliability is high from 0.80 to 1.00. Nunnally (1978) states that the CA value should be 0.70 or higher for reliability. Therefore, it can be concluded that the final scale developed in this study is highly reliable and aligns with similar studies in this context. In summary, a highly valid and reliable scale has been developed that could be used to determine self-efficacy for problem-solving.

Implications

We think that one of the important reasons students have problems in problem-solving is their low self-efficacy in this regard. For this purpose, we recommend further studies to investigate the effects of the results obtained by employing the problem-solving self-efficacy scale, which is proven to be valid and reliable, on students by considering some demographic factors. According to the research results, we suggest projects that will optimize the factors that affect problem-solving self-efficacy meaningfully. In addition, in cases where positive results are obtained from these projects, we think that general approaches applied in all schools can be gained by expanding the study sample.

In addition, according to Yurt (2014), to increase students' mathematics self-efficacies, students' interest and sympathy for mathematics must first be developed. In this context, the relationship between interest and sympathy toward mathematics and problem-solving self-efficacy can be investigated by applying a scale developed because of the research conducted together with a scale that aims to determine the interest and sympathy of students toward mathematics. In addition, the scale developed in experimental studies to improve students' problem-solving self-efficacies can be used as a resource in pre-test and post-test applications.

Another suggestion is to conduct semi-structured interviews with students in cases where students' problem-solving self-efficacy is low and high according to the results obtained and reveal the situations that may affect them. Thus, the content analysis of the answers gathered from the students could be conducted to direct the studies to be carried out under more general themes.

Limitations of the Study

First, in the study, the data obtained in the development and implementation of PSSES is limited to the eighth-grade students in the schools where the study was conducted in the 2020-2021 academic year. In addition, it is thought that the students gave sincere and unbiased answers to all data collection tools used in the research. In this regard, researching larger samples may be beneficial in testing their validity and reliability. Furthermore, considering that self-efficacy is affected by cognitive development, it is necessary to test whether the scale can be used at all middle school, primary school, and high school levels. Therefore, conducting different studies in which students are organized as participants with these levels are recommended.

Second, research is limited to the effects of physical and environmental conditions during the COVID-19 pandemic. Bandura (1995) states that self-efficacy has four dimensions: experiences gained (success and failure), observational experiences (success of others), persuasion process (confirmation of the individual's environment), and affective processes (anxiety, excitement, fears, etc.). Bearing this in mind, the negative emotions during the COVID-19 pandemic may affect students' self-efficacies toward problem-solving. Therefore, the research results obtained after implementing the scale may vary depending on the impact of the ongoing pandemic in different countries.

Acknowledgement and Support

This study was produced from the master's thesis titled "Developing and evaluating a self-efficacy scale towards problem solving" (2021) prepared by Büşra KIRAL under the supervision of Yasemin KATRANCI.

Statement of Contribution Rate

The authors of the study contributed equally to all processes of the study.

Declaration of Conflict of Interest

As the study authors, we declare that we do not have any declaration of interest/conflict.

Permission to Use the Instrument

"The problem-solving self-efficacy scale" developed within the scope of this study is presented in Appendix-1. Researchers can use the scale by giving appropriate citations without additional permission.

Statement of Publication 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 title of "Actions Contrary to Scientific Research and Publication Ethics," which is the second part of the directive, were not carried out.

Scientific, ethical, and citation rules were followed in this study's writing process; no changes were made to the collected data, the participants officially accepted to participate, and this study was not sent to any other academic publication medium for evaluation.

Before the research, a permission document approved by the Governor's Office and the Provincial Directorate of National Education was obtained so that the application could be carried out in official middle schools (dated 29.09.2020 and numbered 99332089/605.01/13743466). In addition, participation in the research was conducted based on the voluntariness of the students, and the parent permission petition forms were obtained from the parents of the students.

Research ethics committee approval information

The committee involved in ethics evaluation: Science and Engineering Sciences Ethics Committee of Kocaeli University

The date of ethics evaluation: 05.03.2020 and 2020/04

The serial number of the document of ethics evaluation: 10017888-100/E.21089

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EXTENDED ABSTRACT

Giriş

Problem çözme, eğitimde geniş bantlı bir konudur çünkü tüm eğitim sistemlerinin temel amaçlarından biri, öğrencilerin kendilerinin ve toplumun karşılaşacakları sorunları çözme yeteneklerini geliştirmelerine yardımcı olmaktır (Mayer, 1999). Bireylerin olgunlaştıkça sorunları kendilerinin çözmeleri ve kendi düşüncelerine dayanarak karar vermeleri beklenir. Ayrıca bireyin kendi problem çözümünü yapmadığı sürece bağımsız bir kişilik olarak bütünlüğünü koruyamayacağı kabul edilmektedir (Bloom vd., 1956). Bu bağlamda problem çözme becerisine sahip olmanın, bireysel yaşam ve toplumsal uyum için eğitim sisteminin her bireyden edinmesini beklediği yeterliklerden biri olduğu söylenebilir.

Öğrencilere problem çözme becerisi kazandırmak için gerekli durumlardan birinin de onları problem çözebileceklerine ikna etmek ve öz-yeterliğe sahip olmalarını sağlamak olduğu düşünülmektedir. Böylece problem çözmede kendisini yeterli hisseden öğrencilerin, matematik dersinde kendisini yeterli hissedeceği ön görülmektedir. Yapılan araştırmalar (Altunçekiç vd., 2005; Chen, 2005; Hoffman & Schraw, 2009; Kesgin, 2006; Yenice, 2012) da öz-yeterliliğin problem çözme performansını artırdığını göstermektedir. Bu kapsamda öğrencilerin problem çözmede yaşadıkları sorunlara çözüm getirebilmek amacıyla öncelikle problem çözmede kendilerini ne kadar yeterli hissettiklerinin araştırılması gerektiği düşünülmektedir. Ancak öğrencilerin problem çözme öz-yeterliklerini ölçmede kullanılabilecek sınırlı sayıda araç bulunmaktadır.

Alanyazında, Pajares ve Kranzler (1995), Dowling'in (1978) geliştirdiği matematik güven ölçeğini, lise öğrencilerinin problem çözmedeki öz-yeterliklerini belirlemek amacıyla genişletmişlerdir. Nicolaidou ve Philippou (2003), beşinci sınıf öğrencileri için problem çözme öz-yeterlik ölçeği geliştirmişlerdir. İncelenen çalışmaların lise ve beşinci sınıf öğrencilerinin problem çözme öz-yeterliklerini belirlemek için geliştirildiği belirlenmiştir. Ayrıca yapılan çalışmalar farklı kültür ve zamanlarda öğrenim görmekte olan öğrencileri içermektedir. Öz-yeterliğin problem çözme başarısındaki etkisi de göz önüne alındığında (Chen, 2005; Hoffman & Schraw, 2009), ortaokul düzeyindeki öğrenciler için ortaokul matematik öğretim programı ve beraberinde değişen amaçlar, beceriler ve yaklaşımları hesaba katarak geliştirilecek bir problem çözme öz-yeterlik ölçeğine ihtiyaç olduğu görülmektedir. Bu doğrultuda bu çalışmada, sekizinci sınıf öğrencilerinin problem çözme öz-yeterliklerini ölçmeyi sağlayan bir ölçme aracı geliştirilmesi amaçlanmıştır.

Yöntem

Ölçek geliştirme metodolojisi birkaç adımı içermektedir. Öncelikle, literatür taraması yapılarak araştırmacılar tarafından 61 maddelik madde havuzu oluşturulmuş ve üç ortaokul matematik öğretmeniyle birlikte incelenmiştir. Madde havuzundaki bazı maddelerde, daha açık ve anlaşılır olması amacıyla düzenlemeler yapılmış ve 43 maddelik yeni bir madde havuzu hazırlanmıştır. Daha sonra bu havuz, matematik eğitimi alanında bir uzman ve ilk incelemedekilerden farklı iki ortaokul matematik öğretmeni ile yeniden incelenmiştir. Yapılan incelemede, maddeler ortaokul seviyesine uygun, açık ve anlaşılır olacak şekilde düzenlenmiş, bazı maddeler çıkarılmış ve sonuçta 39 maddelik taslak ölçek geliştirilmiştir. Sonrasında beş uzman matematik eğitimcisinden görüş alınarak benzer ifadeler barındıran, problem çözme öz-yeterliğini ölçmediği düşünülen ve ortak fikre varılamayan maddeler ölçekten atılmıştır. Yapılan analizlerle 32 maddelik taslak ölçek hazırlanmıştır. Sekizinci sınıf öğrencilerine uygulanan 422 adet veri toplama aracından elde edilen verilerle analizlerin yapılmasına karar verilmiştir. Elde edilen veriler, rastgele iki gruba bölünmüştür. Birinci gruptan elde edilen verilerle (211; 98 kız, 113 erkek) açımlayıcı faktör analizi (AFA) ve madde analizleri gerçekleştirilirken ikinci gruptan elde edilen verilerle (211; 119 kız, 92 erkek) doğrulayıcı faktör analizi (DFA) gerçekleştirilmiştir. Her iki gruptan elde edilen verilerle güvenirlik analizleri yapılmıştır. Ölçeğin iç tutarlığını belirlemede Cronbach alfa (CA) güvenirlik analizi, yapı geçerliği için AFA ve DFA yapılmıştır. Yapılan

analizlerde SPSS 25 ve LISREL 8.7 paket programları kullanılmıştır ve anlamlılık düzeyi 0.05 alınmıştır.

Bulgular

AFA sonucunda, 15 maddelik ve iki faktörlü bir nihai ölçek geliştirilmiştir. Birinci faktör (F1) altında yer alan maddelerin, faktör yük değerlerinin 0.49 ile 0.74 arasında değiştiği görülmüştür. F1 altında bulunan maddeler, öğrencilerin problem çözme ile ilgili olumlu davranış, duygu ve düşüncelerini ifade ettiğinden "problem çözmeye yönelik olumlu öz-yeterlikler" olarak adlandırılmıştır. İkinci faktör (F2) altında bulunan maddelerin faktör yük değerlerinin ise 0.39 ile 0.82 arasında değiştiği belirlenmiştir. F2 altında bulunan maddeler, öğrencilerin problem çözme ile ilgili olumsuz davranış, duygu ve düşüncelerini ifade ettiğinden "problem çözmeye yönelik olumsuz öz-yeterlikler" olarak adlandırılmıştır. Ayrıca faktörlerin toplam varyansa katkıları F1'in %26.66, F2'nin %22.91'tür. Ortaya çıkan iki faktörün varyansa yaptıkları toplam katkı ise %49.58'dir.

AFA sonrasında maddelerin uygulamasından oluşan sonuçların, seçilen ölçüte uygunluğunu, değilse olası sebeplerini bulmak ve amaca hizmet etmesini sağlamak için yapılan madde analizleri; önce ölçeğin tamamı için sonrasında her alt faktörü için yapılmıştır. Araştırmanın madde analizi yapılırken 0.01 anlamlılık düzeyi esas alınıp madde toplam korelasyonu (MTK) ve madde kalan korelasyonu (MKK) gerçekleştirilmiştir. Ölçeğin tamamına ilişkin MTK ve MKK değerleri 0.01 düzeyinde anlamlı bulunmuştur. Ölçeğin alt faktörleri arasındaki korelasyon katsayısı incelendiğinde, F1 ile F2 arasındaki 0.45; F1 ile ölçeğin tamamı arasındaki 0.87; F2 ile ölçeğin tamamı arasındaki 0.82 olarak belirlenmiştir. DFA sonucunda, ölçeğe ait X^2/sd oranı 1.84; RMSEA 0.06; NFI 0.96; NNFI 0.98; CFI 0.98; RMR 0.06 ve SRMR 0.05 olarak hesaplanmıştır.

Güvenirlik analizi için öncelikle 32 maddelik taslak ölçeğin CA güvenirliği hesaplanmıştır. AFA sonrasında kalan 15 maddenin tümü ve alt faktörleri için güvenirlik analizleri yapılmıştır. Sonuçta CA değerleri; ölçeğin tamamı için 0.91, F1 için 0.88 ve F2 için 0.87 olarak hesaplanmıştır.

Tartışma ve Sonuç

Öncelikle geliştirilen ölçeğin iki faktörlü bir yapıda olması, öz-yeterliğin farklı boyutlarını içerdiğinin bir kanıtı olarak değerlendirilebilir. F1 ve F2'nin açıkladıkları toplam varyans oranı %49.58'dir. Araştırmacılar, sosyal bilimlerde açıklanan varyans oranının %40-60 arasında olmasını yeterli görmektedirler (Scherer vd., 1988). Dolayısıyla geliştirilen ölçekte tanımlayıcı bir faktörün toplam varyansa katkısı yeterli kabul edilebilir.

İkincisi, ölçek maddelerinin yeterince ayırt edici, geçerliği yüksek ve aynı yapıyı ölçtüğü belirlenmiştir. Korelasyon değerleri; F1 ile ölçeğin tamamı arasında 0.87, F2 ile ölçeğin tamamı arasında 0.82 olarak hesaplanmıştır. Korelasyon değeri; 0.70-1.00 arasında yüksek, 0.30-0.70 arasında ise orta düzeydedir (Büyüköztürk, 2018). Dolayısıyla bu çalışmada elde edilen korelasyon katsayıları yüksek düzeydedir. F1 ile F2 arasındaki korelasyon değeri 0.45 olarak hesaplanmış ve aralarında orta düzeyde bir korelasyon olduğu saptanmıştır. Alt faktörler arasındaki bu ilişki seviyesi arzu edilir.

Üçüncüsü, DFA sonucunda X^2/sd oranı 1.84 olarak mükemmel uyum (Kline, 2005), RMSEA değeri 0.06 olarak iyi uyum (Thompson, 2004), NFI değeri 0.96, NNFI değeri 0.98 ve CFI değeri 0.98 olarak mükemmel uyum (Sümer, 2000; Tabachnick & Fidell, 2015), RMR değeri 0.06 ve SRMR değeri 0.05 olarak iyi ve mükemmel uyum (Brown, 2006) sağladıkları belirlenmiştir.

Dördüncüsü, güvenirlik analizleri yapılmıştır. Tüm ölçeğin CA değerleri 0.91, F1 ve F2'nin CA değerleri sırasıyla 0.88 ve 0.87 olarak hesaplanmıştır. Nunnally (1978), güvenilirlik için CA değerinin 0.70 veya daha yüksek olması gerektiğini belirtmektedir. Dolayısıyla bu çalışmada geliştirilen ölçeğin oldukça güvenilir olduğu ve yapılan çalışmalarla (Nicolaidou & Philippou, 2003; Pajares & Kranzler, 1995) örtüştüğü söylenebilir. Özetle, problem çözme öz-yeterliğini belirlemek için kullanılabilecek oldukça geçerli ve güvenilir bir ölçek geliştirilmiştir.

Appendix-1. Problem Çözmeye Yönelik Öz-Yeterlik Ölçeği (PÇYÖYÖ)

Değerli öğrenciler, Aşağıda matematik problemlerini çözme ile ilgili bazı ifadeler yer almaktadır. Lütfen her bir ifadeyi okuyunuz. Her bir ifadeyi okuduktan sonra, ifadeye katılma/katılmama derecenize göre, ilgili kutucuğa "X" işareti koyunuz. Lütfen hiçbir soruyu cevapsız bırakmayınız. Verdiğiniz cevaplar ders notlarınızı etkilemeyecek, bilimsel bir çalışma için kullanılacak, herhangi başka bir amaçla kullanılmayacak ve cevaplarınız kesinlikle gizli tutulacaktır. Katkılarınızdan dolayı çok teşekkür ederim.		Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1	Bir matematik problemini birden fazla yol ile çözebilirim.					
2	Bir matematik problemini çözebilmek için strateji geliştirebilirim.					
3	Resim, geometrik şekil ve/veya grafik içeren matematik problemlerini çözerken güçlük çekerim.					
4	Problem çözülen matematik derslerine aktif olarak katılırım.					
5	Herhangi bir matematik problemini çözebilirim.					
6	Matematik problemlerini çözerken genellikle kendimi yetersiz hissederim.					
7	Matematikteki alıştırmaları kolayca yapabilirken problemleri çözmede güçlük çekerim.					
8	Matematik problemlerini genellikle anlayamadığım için çözmede güçlük çekerim.					
9	Matematik problemlerini çözmede sınıf arkadaşlarıma kıyasla kendimi yetersiz bulurum.					
10	Matematik dersinde kendime güvenirim ama genellikle problemleri çözemem.					
11	Problem çözdükçe matematikte kendime olan güvenim artıyor.					
12	Bir matematik problemini çözerken kullandığım stratejiyi başka bir matematik problemini çözmek için de kullanabilirim.					
13	Bir matematik problemini yanlış çözdüğümde doğru çözümü elde edene kadar çabalarım.					
14	Zor bir matematik problemini uğraşarak çözebilirim.					
15	Çevremdekilerin matematik problemi çözmede iyi olduğumu söylemesi problem çözebileceğime olan inancımı artırır.					