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The Effect of The Modified Solve It! Strategy on The Mathematical Problem-Solving Skills of Students with Learning Difficulties[1]

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ABSTRACT

Problem-solving skills, which require the active use of many cognitive strategies, are a difficult and comprehensive process for students with learning disabilities. The Solve It! Strategy developed by Montague (1992), includes the cognitive and metacognitive skills required to solve problems. In this study, the effect of the Modified Solve It! Strategy on the addition and subtraction problem-solving skills of students with learning disabilities was investigated. Thestudy aimed to find the following: The effect of the Modified Solve It! Strategy on the problem-solving skills of students with learning difficulties for change problems, including one-step addition and subtraction; the effect of the strategy on the generalization of their problem-solving skills to comparison problems, including one-step addition and subtraction problems; whether the students were able to use the cognitive and metacognitive skills after the instruction of the Modified Solve It! Strategy; the views of the students and families on the Modified Solve It! Strategy. The study was conducted in the Sincan of Ankara with three students with learning difficulties in classes. The study was carried out with multiple probe designs across subjects. The research was carried out in four stages: collecting baseline data, teaching strategy, collecting post-teaching data, and collecting monitoring data. The teaching process was carried out in eight steps: revealing prerequisite skills, introducing the strategy, modeling, memorizing the strategy, guided application, independent application, fading, and evaluation. The experimental data that was obtained was analyzed using graphics. As a result of the research, it was seen that the Modified Solve It! Strategy applied to students with learning disabilities was effective in solving mathematical problems.

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[1] The current study is part of the first author's MSc. thesis submitted to the Department of Educational Sciences/Necmettin Erbakan University in October 2020 under the supervision of the co-author. In addition, this study was published as a paper at the 31st National Special Education Congress.

INTRODUCTION

Problem-solving skills, which are the main targets of different disciplines, are skills that we use most in daily and academic life, and are among the most important skills of the 21st century. Problem-solving is a difficult and comprehensive process as it requires the active use of skills such as calculating, predicting, and thinking (Joyner & Reys, 2000).

Montague (2000) has defined solving mathematical problems as a cognitive activity that includes several mathematical processes and strategies. During mathematical operations, cognitive and metacognitive processes and strategies are used (Montague & Dietz, 2009). The problem-solving process includes the following processes: comprehension, translating, transformation, planning, predicting, calculating, and evaluation (Montague, 1992). Metacognitive processes include making predictions about problem-solving, evaluating the solution process constantly, and having the ability to monitor answers (Montague & Applegate, 1993). Students with learning difficulties experience problems related to attention, memory, and organizing themselves, and these problems affect their mathematical performances negatively (Swanson & S'aez, 2003, as cited in Montague, 2007). In addition, these problems that children with learning difficulties face daily, cause them to experience problems when using problem-solving and self- regulation (Montague & Applegate, 1993). Researchers have stated that overtly structured teaching is not sufficient for teaching mathematical problem-solving skills to children with learning difficulties, and have expressed that they should have strategy instruction in order to use cognitive and metacognitive skills effectively and actively in order to maintain a successful problem-solving process (Montague, 1997). It was observed that when students with learning difficulties are taught how to use problem-solving strategies, their problem-solving skills are as good as their peers (Montague & Applegate, 1993).

During strategy instruction, cognitive routines, metacognitive, and self-organization strategies are used in order to enable students to develop their comprehension, monitoring, and evaluation processes (Teaching LD, 2020, February 12). Cognitive strategy consists of the following seven stages, respectively; revealing prerequisite skills, introducing the strategy, creating a model, memorizing the strategy, guided practice, and evaluation (Reid & Lienemann, 2006). Apart from these seven stages, cognitive strategy includes creating a model by thinking aloud in order to reveal cognitive processes that are not normally seen in the teaching process, interactive dialogues in which the teacher shows the students how to think aloud and how the strategy is used, and scaffolding, which is used to facilitate the thinking process of the student. These three factors are important factors for cognitive strategy instruction (Guzel- Ozmen, 2006).

Montague and Dietz (2009) conducted a study in which they analyzed the effects of cognitive strategy instruction on the mathematical problem-solving skills of students with learning difficulties. As a result of this study, it was observed that the cognitive strategy instruction used to develop the mathematical problem-solving skills of students with learning difficulties does not meet evidence-based criteria. Montague and Dietz (2009) have stated that it is crucial for researchers to conduct further studies on cognitive strategy instruction by taking into consideration quality standards and criteria in order to identify the shortcomings in empirical literature and evidence-based applications. One of the findings by Ozkubat et al. (2020) in their study, in which they studied the research conducted, including the 'Solve It! Strategy' was that further research should be conducted in order to promote the problem-solving skills of students with special needs.

The Solve It! Strategy developed by Montague (1992), which contains the cognitive and metacognitive skills necessary for solving problems, is a process based strategy instruction model.

The Solve It! Strategy contains seven steps, which are: read, paraphrase, visualize, hypothesize, estimate, compute, and check. In addition, each of these seven steps has self-instruction, self-questioning, and self-monitoring strategies (e.g., say, ask, check), and these steps equal metacognitive strategies

(Montague, 1992). Self-regulation skills are metacognitive strategies. The self-regulation skills consist of different strategies: antecedent cue regulation, self-instruction, reinforcement, monitoring oneself, and evaluating oneself (Koegel & Koegel, 1990, as cited in Aykut, 2013). Antecedent cue regulation, which is a self-regulation skill in the Solve It! Strategy, corresponds to the 'Say it' step, and this step requires the students to train themselves. The 'Say it' step helps the students define and direct themselves while solving problems. The 'Ask it' step, which corresponds to the self-instruction in self-organization skills, promotes inner dialogue, which helps in organizing the implementation of cognitive processes, and aids in systematic analysis of information. The 'Ask It' step enables students to question themselves. The 'Check' step, which corresponds to the self-monitoring strategy of self-organization skills, motivates students to use strategies correctly, and enables students to monitor their performance during the problem-solving process (Montague & Dietz, 2009).

Researchers have carried out numerous studies with different groups with special needs using different research patterns in which the Solve It! Strategy is used. Some researchers have made adaptations to the stages and steps of the Solve It! Strategy in their research. Chung and Tam (2005) eliminated the 'make an assumption' and 'make a prediction' stages of the Solve It! Strategy and modified it as a five-step strategy, which included the 'read the problem aloud, select the most important information, make a visual of the problem, make a calculation, and check the answer' stages. In their adaptation, they remained loyal to the steps 'say it, ask a question, and check it' in Montague's Solve It! Strategy. Karabulut (2015) developed Understand and Solve! by adapting Montague's Solve It! Strategy. The Understand and Solve It! Strategy that was developed consists of five stages: read the problem and tell, underline the keywords, draw the schema of the problem, make a plan and solve the problem, and check (Ozkubat & Karabulut 2021). Karabulut (2015) did not include the steps 'say it, ask it, and check it' in the Solve It! Strategy developed by Montague in his adaptation, and included self-regulation skills in the instruction process.

Reviewing the literature, it is observed that there are numerous international studies on teaching problem-solving skills during which cognitive strategy instruction is used. As a result of the literature review, it is observed that there is no research in Turkey during which cognitive strategy instruction was conducted with students with learning difficulties (Ozkubat & Ozmen, 2018). It is crucial to conduct studies on this topic in order to identify the strategies used by students with learning difficulties in solving mathematical problems (Ozkubat & Ozmen, 2018).

As a study conducted with cognitive strategy instruction on mathematical problem-solving skills of students with learning difficulties cease to exist in Turkey, and as there is limited research on this subject in which evidence-based implementations are used, the aim of this study is to study the effectiveness of the Modified Solve It! Strategy on the mathematical problem-solving skills of students with learning difficulties.

METHOD

Research Design

It was decided that the multiple probes across participants design would be used in this study in order to examine the effect of the Solve It! Strategy on the mathematical problem-solving skills of students with special needs. The multiple probes across participants pattern were designed as multiple probes design with multiple conditions.

In order to study the opinions of the students and the parents, the semi-structured interview technique, which is a qualitative research method, was used.

Dependent and Independent Variables

The dependent variable of the study was the number of problems that the students solved accurately, whereas the independent variable was the Modified Solve It! Strategy.

Participants

This study was conducted with three students with learning difficulties who were attending school in the Sincan of Ankara.

The first student

A 12 year-3 month-old female student diagnosed with learning difficulties, attending grade 6. She takes additional math classes. She was able to solve 10 mathematical operations with addition with carry 100% accurately. Similarly, she was able to complete 10 operations with subtraction without borrowing 100% accurately. She was able to solve 4 of the 10 change problems including one step addition and subtraction. She attends classes regularly.

The second student

A 12 year-5 month-old female student diagnosed with learning difficulties, attending grade 6.She takes additional math classes. She was able to solve 10 mathematical operations with addition with carry 100% accurately. Similarly, she was able to complete 10 operations with subtraction without borrowing 100% accurately. She was able to solve 4 of the 10 change problems including one step addition and subtraction. She attends classes regularly.

The third student

An 11 year-6 month-old female student diagnosed with learning difficulties, attending grade 7. She takes additional math classes. She was able to solve 10 mathematical operations with addition with carry 100% accurately. Similarly, she was able to complete 10 operations with subtraction without borrowing 100% accurately. She was able to solve 3 of the 10 change problems with one step addition and subtraction. She attends classes regularly.

The Development of The Modified Solve It! Strategy

During the research five steps of the seven steps of Montague's (1992) Solve It! Strategy, which are 'read, paraphrase, visualize, hypothesize, predict, calculate and check' were used as modified by Chung and Tam (2005) and later used in research. These five steps are 'read, paraphrase, visualize, plan and calculate, and check.' In the study, the steps 'say, ask, and check,' which enable the students to use self-regulation skills and metacognitive skills, were used as they were. In the 'visualize' stage of the study, the students were asked to choose the appropriate schemas, and to fill them in as in the strategy modified by Karabulut (2015) as different to the strategy modified by Chung and Tam (2005). During strategy instruction, the cognitive strategy instruction was used as cognitive strategy instruction is evidence-based. In addition, appropriate scaffolding which are used in cognitive strategy instruction, and which enable the students to internalize the strategy, and use self-organization skills were used during the process.

Table 1. *The steps of the modified Solve It! strategy*

Steps of the Strategy	Dimensions of the Strategy
Read (In order to understand the problem)	Say: Read the problem. Answer the questions on the Reading the Problem Check List.
	Ask: Have I read the problem and understood it?
	Check: I must make sure that I understand in order to solve the problem better.
Explanation (Paraphrasing it in your own words)	Say: Underline important information and key words.
	Ask: Have I underlined important information? What is the question? What am I looking for?
	Check: I must make sure that the key words I have underlined are appropriate for the question.
Visualize (Draw the schema)	Say: Make a schema.
	Ask: Is the schema I have drawn appropriate for the problem?
	Check: I must make sure that the schema is suitable for the problem.

Plan and Calculate (Create the plan for solving the problem and solve)	Say: Decide on how many calculations are needed and which ones will be made. Write the calculations on the Planning Sheet. Solve the calculations in the correct order.
	Ask: How many steps are needed? Which processes do I have to carry out? Is my answer meaningful?
	Check: I must make sure that the plan is logical and that all the steps are carried out in the correct order.
Check (Make sure that everything is correct)	Say: Check your steps and your calculations.
	Ask: Have I checked every step? Have I checked the calculations? Is my answer correct?
	Check: I must make sure that everything is correct. If not, go back. Ask for help if you need it.

The Implementation Steps of The Modified Solve It! Strategy

Teaching the Modified Solve It! Strategy, the independent application step for the cognitive strategy instruction consisting of seven stages, was divided into two independent practice and withdrawal stages, and the application was conducted in this way. During the application, the following stages were followed: revealing prerequisite skills, introducing the strategy, creating a model, memorizing the strategy, guided practice, independent practice, withdrawal, and evaluation.

The Scaffolding Used in The Strategy

Scaffolding is an important factor that enables students to learn strategies and internalize them during cognitive strategy instruction (Case et al., 1992; Guzel-Ozmen, 2006; Karabulut, 2015; Reid & Lienemann, 2006). During the research process, scaffolding was used to enable students to learn the Modified Solve It! Strategy easily. The scaffolding used in this study was an observation sheet for the Modified Solve It! Strategy, a check list for reading the problems, problem schemas, a planning sheet, a problem-solving sheet, and a Modified Solve It! Strategy checklist.

Data Collection Tools

In order to assess the changes in the dependent variable in the study, the following data collection tools were used: preparing the problems; a problem evaluation sheet, which includes preparing the problems; addition and subtraction problems; a strategy observation form; and a social validity questionnaire.

The Research Process

This research was conducted in five stages: the collection of baseline data, the Solve It! Strategy instruction, collecting the evaluation data, monitoring, and generalization. A preliminary application was carried out in order to prevent possible problems during the research process and to adjust the length of the sessions. An observer observed the preliminary application stage and filled out a practice reliability form. Thus, the shortcomings of the research process were identified. The preliminary application process ended when the application reliability was 80%. During the experimental process, there were one-on-one sessions every day with each student at specific times.

The Collection and Scoring of Data

In order to identify their problem-solving performances, the students were given a problem evaluation sheet, and they were given the instruction, ‘I want you to solve the problems written on this sheet. You may leave a question blank if you wish to’. After the student had solved the problems, the answers were written in the problem-solving performance recording chart by the teacher as ‘correct, incorrect, or blank’. In order to accept the solution to a problem as correct, special care was taken to guarantee that both the solution and the result were correct. If there was a mistake in any step of the solution to the problem, that example was considered to be incorrect. The correct answers of each student were found by looking at the problem-solving performance recording chart, and the correct answers of the students were evaluated as their performance. Similarly, baseline data, post-instruction data, monitoring data and generalization data, were collected and

scored in the same way.

Data Analysis

Graph analysis was used for analyzing the problem-solving performance data of the students. The data was analyzed using a line graph. The data, which was collected using the semi-structured interview form, were interpreted and analyzed using descriptive analysis, whereas the social validity data collected using the questionnaire were interpreted using frequency.

Reliability Data

Before collecting the reliability data, the limitations of the target were determined. The targets were written clearly using observable and measurable terms, and they were prepared as an implementation reliability form. During the study, implementation reliability was collected by a special education teacher using the Implementation Reliability Data Collection Form. The observer sat in a part of the classroom where the student would not see him or her, observed the implementation process, and put ticks on the data recording form. The percentage for implementation reliability is calculated by dividing the observed practitioner behavior by the planned practitioner behavior and multiplying it by 100 (Erbas, 2018).

The observer observed only the implementation process and the evaluation process of the first and third students completely. The observer was asked to watch at least 30% of the videos recorded during the implementation process and the evaluation process, which were selected randomly, and fill out the Implementation Reliability Data Collection form. Special care was taken to include videos for every student and every implementation stage while selecting the videos randomly. The implementation reliability of the study was found to be 96.75 percent as a result of the reliability data that was collected. The implementation reliability according to students and implementation sessions is presented in Table 2.

Table 2. *Implementation reliability data*

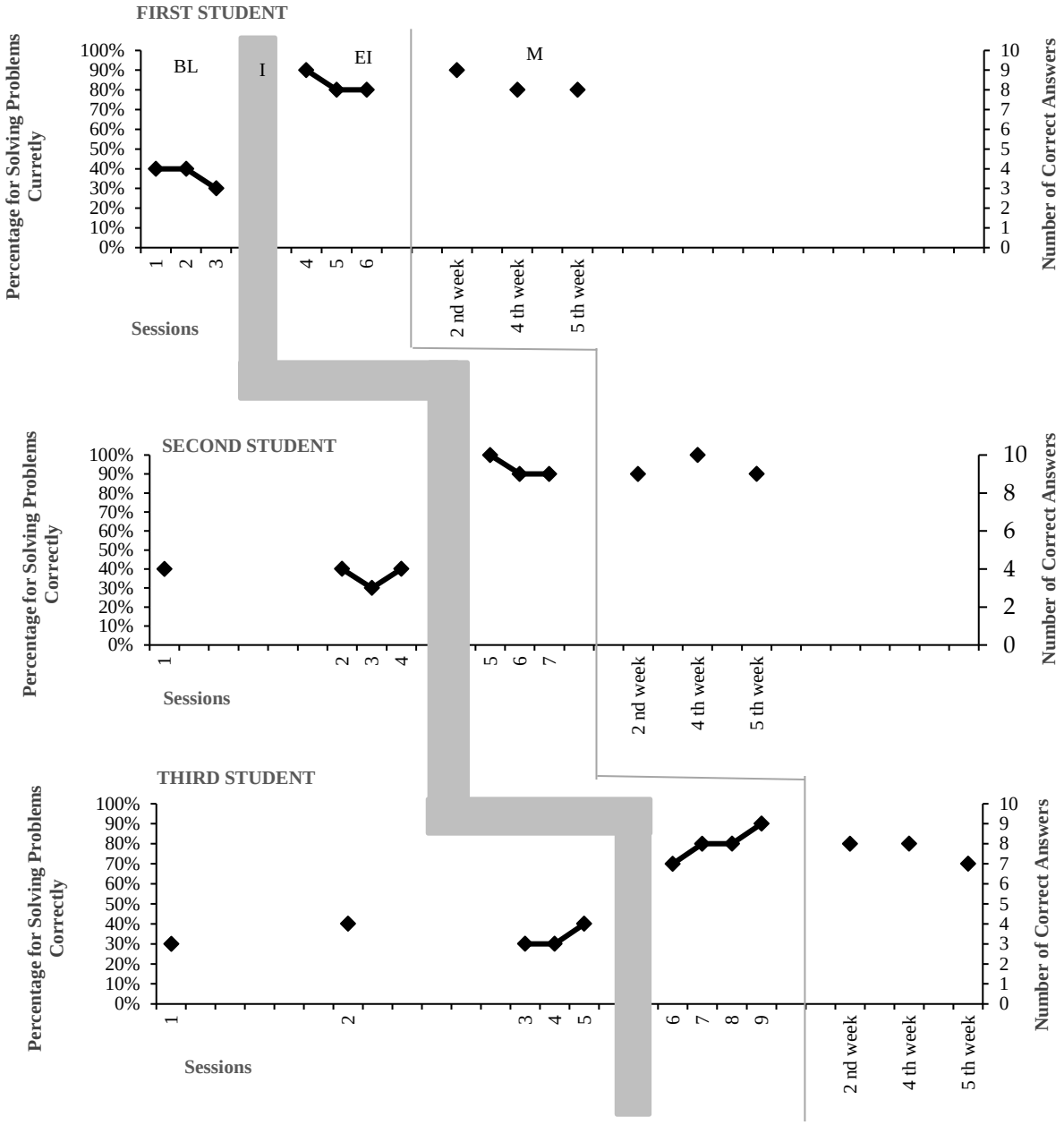
		Implementation								
Students	Evaluation	Activating Prerequisite Skills	Introducing the Strategy	Creating a Model	Memorizing the Strategy	Implementing the Guidelines	Independent Implementation	Withdrawal	Generalization	Total
First Student	100%	100%	93,75%	100%	100%	100%	100%	94%	90,9%	97,62%
Second Student	100%	88,8%	100%	97,1%	100%	100%	100%	89%	90,9%	96,2%
Third Student	100%	100%	93,75%	93,75%	100%	100%	100%	89%	90,9%	96,37%
Total	100%	96,26%	95,83%	96,95%	100%	100%	100%	90,66%	90,9%	96,73%

To calculate the reliability, the observer was asked to watch at least 30% of the implementation evaluation sessions (baseline, post-instruction evaluation, monitoring, and evaluations related to generalization). The observer was given an Observer Reliability Form, and he or she was asked to fill out the form according to the performance of the student by watching the videos. After the observer watched the videos and filled out the forms, the observer's reliability was calculated by comparing the evaluations of the researcher and the observer. To calculate observer reliability, the observer and researcher's disagreement was divided by the total of disagreement and agreement between the observer and the researcher and multiplied by 100 (Erbas, 2018).

For the first student, approximately 35% of the evaluation sessions (baseline, post-instruction, monitoring, generalization baseline, generalization post-instruction, and generalization monitoring) were watched. Similarly, for the second student, approximately 31%, and for the third student, approximately 31% of the evaluation sessions were watched. The observer's reliability was found to be 100% for all three students.

FINDINGS

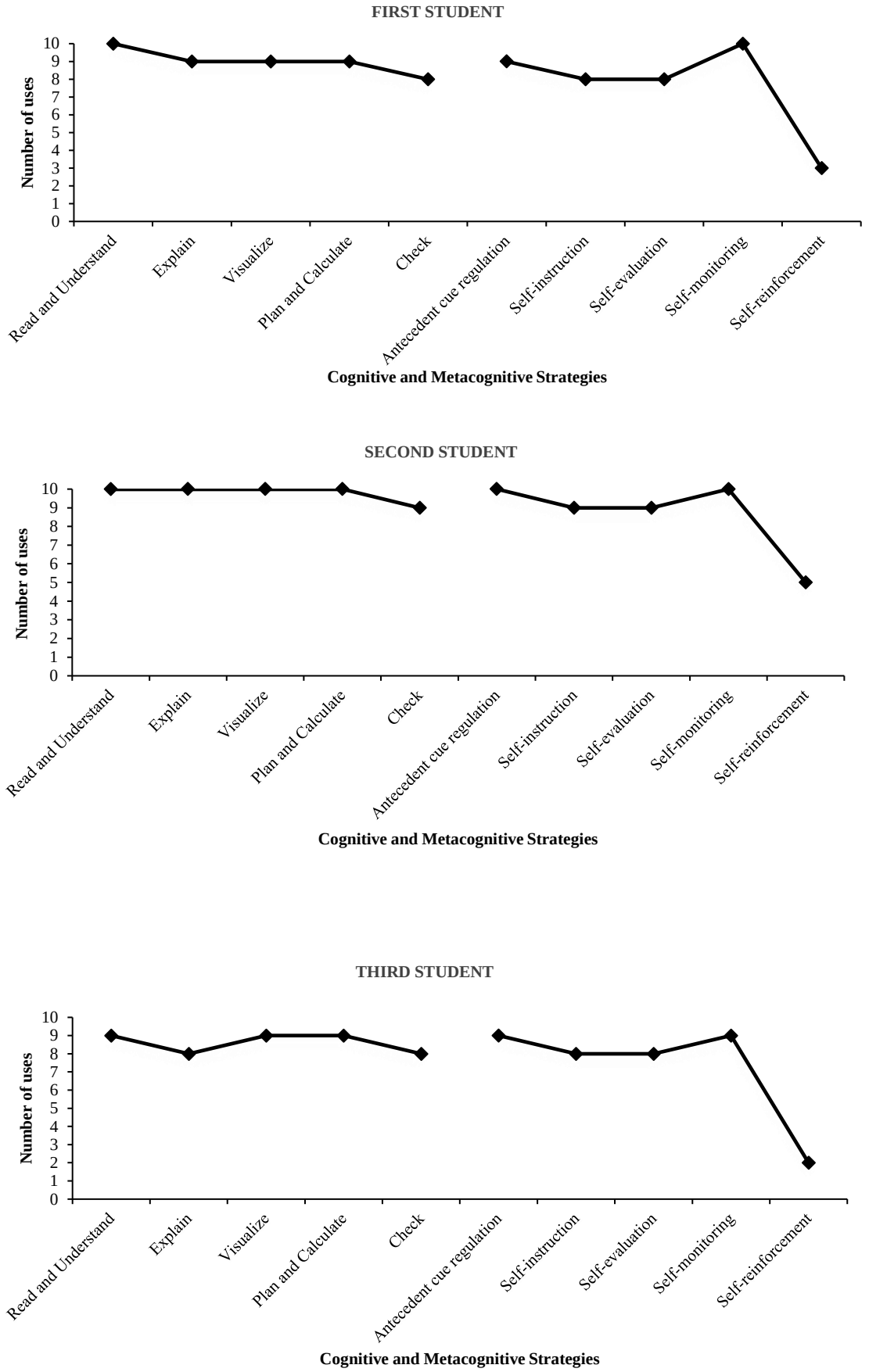
The data for the baseline, post instruction and monitoring for the problem-solving performances of the students for change problems with addition and subtraction are presented in Graph 1.



Graph 1. *Findings on baseline, post instruction and monitoring process of students' problem-solving performances for the change problems with addition and subtraction problem*
(Note. *BL: baseline, I: instruction process, EI: end of instruction, M: monitoring)*

Studying the baseline data, it was observed that all three students had a maximum of four correct answers in evaluations, including 10 problems. An increase was observed in the problem-solving skills of all three students after the students received the Modified Solve It Strategy instruction, and all students met the 80% accuracy criterion. While the post-instruction data became consistent faster for the first and second students, this took a longer time for the third student. It was observed that all students maintained the post instruction achievement levels in the monitoring data collected two weeks later and four weeks later. However, although there was no decrease in the performance of the first and second students in the monitoring data that was collected five weeks later, it was observed that there was a decline in the performance of the third student and that the students' performance fell to 70%.

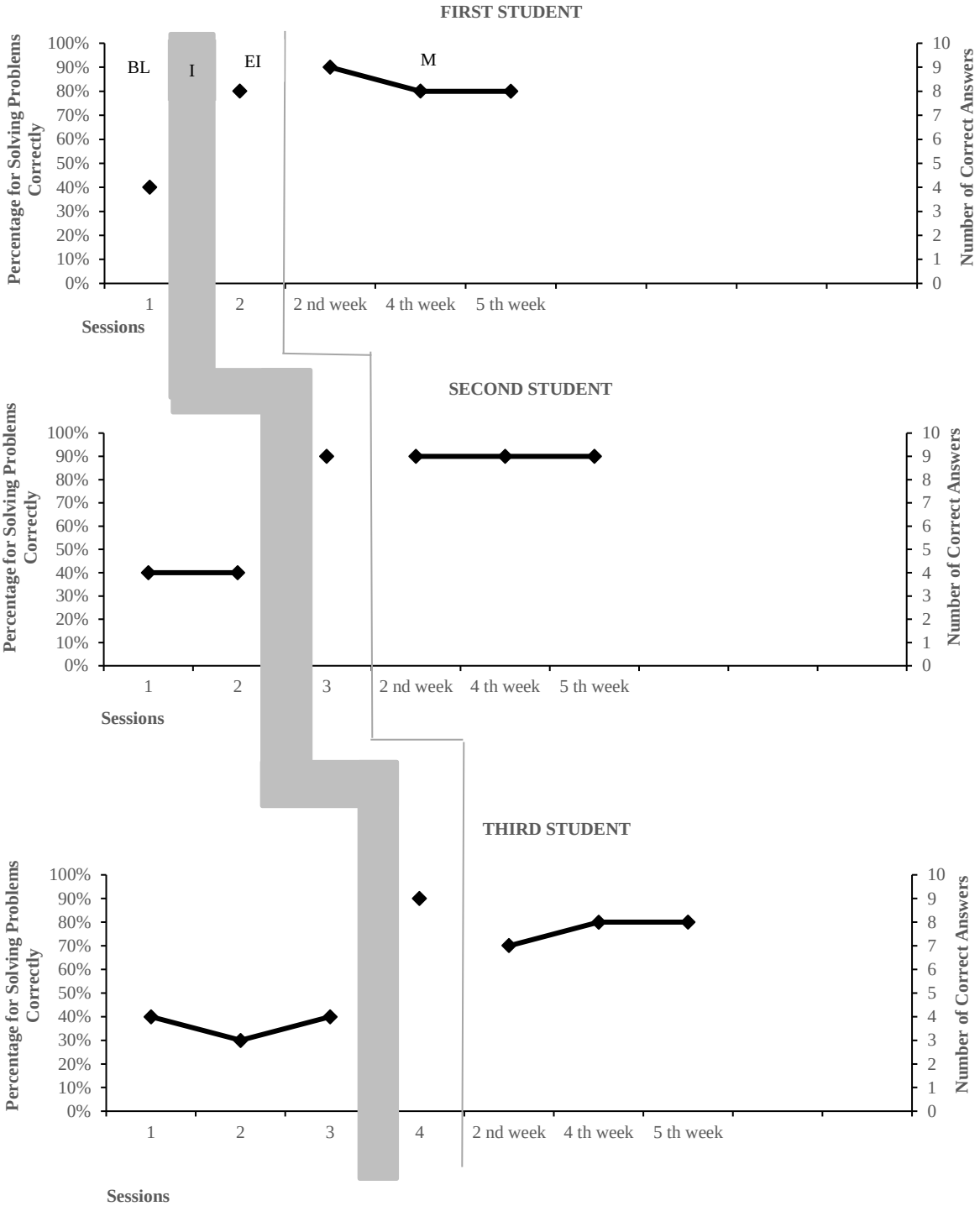
Graph 2 illustrates how much of the cognitive and metacognitive strategies in the Modified Solve It! Strategy were used by the students following instruction.



Graph 2. *Findings on the students' performance while using strategies*

It was observed that all three students used the cognitive and metacognitive strategies 'read and understand, explain, visualize, plan and calculate check, antecedent cue regulation, self-instruction, self-evaluation, self- monitoring' effectively while solving problems. However, it was seen that they were not able to use the metacognitive strategy 'self-reinforcement' effectively.

The ability of the students to generalize the Modified Solve It! Strategy to comparison problems with addition and subtraction are presented in Graph 3.



Graph 3. *Findings on baseline, post instruction and monitoring process of students' problem-solving performances for the comparison problems with addition and subtraction*
(Note. *BL: baseline, I: instruction process, EI: end of instruction, M: monitoring)*

While the baseline data was four correct answers in general for all three students, it was observed that the problem-solving performances of the students for comparison problems increased to 80% and 90% after generalization instruction. When the data collected after instruction is compared to baseline data, it was observed that there was a significant increase in the problem-solving performance of the students. That is, students with learning difficulties generalized their problem-solving performances for solving change problems that they developed with the Modified Solve It! Strategy to comparison problems. It was observed that there was no decrease in the performance of the first and second students based on the monitoring data collected two weeks, four weeks, and five weeks after post-instruction sessions, and that they maintained their learning. It was observed that the performance of the third student fell to 70% in the monitoring data collected two weeks later. However, it was also observed that there was no change in the performance of the third student in the monitoring data, which was collected four weeks and five weeks later, and that she met the 80% accuracy criterion.

The data, which was collected using the 5-point Likert scale social validity form, was administered to the students in order to determine their thoughts on the Modified Solve It! Strategy are presented in Table 3.

Table 3. *The social validity questionnaire scores of the students*

Questionnaire Questions	First Student	Second Student	Third Student
Using the strategy makes it easy to solve problems	5	5	5
I will use the strategy	5	5	5
Using the strategy enables me to solve problems faster	5	5	3
Using the strategy is fun	5	5	5
Using the scaffolding is fun	5	5	4
The graphs help me understand the problems more easily	5	5	5
I can use the strategy without the scaffolding	5	5	5
I can draw the graph myself	5	5	5
Thinking aloud helps me	5	5	3
Telling myself what to do helps me	5	5	5
From now on, I will tell myself what to do	5	5	5
Asking questions to myself helps me	5	5	5
From now on, I will ask questions to myself	4	5	4
Evaluating myself helps me	5	5	5
From now on, I will check myself	5	5	5

It was found out that most of the evaluations of the students for the Modified Solve It! Strategy were positive, and the students stated that they completely agreed by giving five points to most of the items. However, the third participant stated that she was indecisive by giving three points to the item 'The strategy enables me to solve problems faster'. On the other hand, she stated that she agreed with the item 'It is fun to use scaffolding' by giving it four points. It was observed that students completely agreed with items on metacognitive strategies as a whole. The first student and the second student gave four points to the item 'I will ask questions to myself from now on' and stated that they agreed.

The data that was obtained by administering the semi-structured interview to the students was analyzed and interpreted using descriptive analysis. In light of the social validity form and the semi-structured interview that were administered to the students, the social validity of the Modified Solve It! strategy and the social validity of the study were found to be high. However, although the students were expected to generalize the metacognitive strategies in the strategy instruction process to daily life, the data obtained by using semi-structured interviews has revealed that the expected outcomes were not achieved.

The data obtained from students by using the 5-point Likert scale social validity form was used to determine the views of the families on the Modified Solve It! strategy and social validity are presented in Table 4.

Table 4. The Social Validity Questionnaire Scores of the Families

Questionnaire Questions	First Student	Second Student	Third Student
My child is more willing when solving maths questions	4	5	4
My child has more correct answers for the problems that s/he solves at home.	5	5	5
My child asks for less help when s/he solves problems.	5	5	5
My child visualizes the problem by making various drawings while solving problems.	5	5	5
My child spends less time while solving problems.	4	5	4

Based on the answers the parents have given to the questions in the questionnaire, it is observed that the students transfer the strategy to home settings, and that the parents are also pleased with this situation.

DISCUSSION

The Efficiency of The Modified Solve It! Strategy

During the implementation stage of the research, the students were taught the Modified Solve It! strategy. Based on the data following the instruction of the strategy, it was observed that there was an increase in the performance of students in change problems, which included addition and subtraction. It was observed that the average performance of students was 30–40% for baseline data that was collected prior to the Modified Solve It! strategy. On the other hand, it was observed that the average performance of students was 80–90% in the data that was collected following the instructions of the Modified Solve It! strategy. The baseline data and the data collected after instruction on the strategy show that the Modified Solve It! strategy positively affected the performance of students when solving change problems, which included addition and subtraction. This result, which was obtained as a result of the study, displays similarities with research that studied the effectiveness of the Solve It! strategy or the Modified Solve It! strategy by using different research methods.

The results of this research and the results of other studies in the literature point out that strategy instruction is effective in helping students with learning difficulties acquire problem-solving skills for math and other academic skills and that these students can learn and use these strategies (Daniel, 2003; Freeman-Green et al., 2015; Jitendra, 2002; Krawec, 2014; Mercer & Miller, 1992; Montague, 1992; Montague & Bos, 1986; Montague et al., 2014; Owen & Fuchs, 2002; Ozmen & Ozkubat, 2018; Pfannenstiel et al., 2015; Zhu, 2015).

When monitoring data was collected in the second, fourth, and fifth weeks after the instruction of the Modified Solve It! strategy to students, it was observed that the students maintained their performance following the instruction on the whole. A slight decrease was observed in the performance of the third student in week five. Based on the data obtained, it may be said that on the whole, the Modified Solve It! strategy can be used by students for a long time and that it is an effective strategy as the improvement in the performance of students is maintainable. It is believed that as students are able to maintain their performance two, three, and five weeks later, this is related to the self-regulation skills in the Modified Solve It! strategy as well as the effective use of these strategies by the students. Similarly, in their study, Cassel and Reid (1996) stated that metacognitive strategies were effective in their maintenance. In his studies, Montague (1992) stated that it would be beneficial to provide support to the students by using reinforcement sessions and other types of teaching, as students would experience a decrease in their performance for using the strategy after long intervals. In this research, no support or teaching was provided for the students following the teaching process. The fact that the performance of the third student fell to 70% in the monitoring session in the fifth week reveals that reinforcement sessions are vital for the students to maintain their performance and to be able to use the strategy for longer periods.

While prior to the generalization instruction, the performance of the students for solving comparison problems with addition and subtraction was 40%, their performance rose to 80% following the generalization instruction. Thus, there was a significant increase in performance.

It was observed that, on the whole, the students preserved their generalization performance in the monitoring data, which was collected two weeks, four weeks, and five weeks later. A slight decrease was observed in the performance of the third student in the fourth week.

When the performance of the students is studied, it is observed that the students generalize the Modified Solve It! strategy to different types of problems. The increase in the generalization performance of the students was related not only to their generalization of problem-solving but also to their generalization of the cognitive and metacognitive processes in the strategy. Cognitive and metacognitive strategies had an effect on the maintenance of the students' generalization performances in the second, fourth, and fifth weeks following instruction. The fact that the second-week performance of the third student was lower than the monitoring data collected in the fourth and fifth weeks was interpreted as the possibility of the student being affected by environmental factors on that day. Montague and Bos (1986) reached the conclusion that students with learning difficulties generalized the Solve It Strategy to problems with increasing levels of difficulty, whereas Whibity (2015) concluded that students with autism spectrum disorder generalized the Solve It! strategy to different environments. Similarly, Karabulut (2015) concluded that students with mild mental disabilities generalized the Understand and Solve It! strategy (modified from the Solve It! strategy) to different environments, different types of problems, and problems with increasing difficulty. Similarly, based on data, this study has reached the conclusion that students with learning difficulties generalize this cognitive strategy to different problem types, and the findings support literature.

The students have stated that they found the cognitive strategy fun and easy to use, are pleased with the stages in the strategy, and that they will use the strategy in the future while solving problems. In addition, they have expressed that thinking aloud and using scaffolding are fun, and that using the strategy helps them understand where to start when solving the problem. They have also stated that using the strategy makes problem-solving easier. According to the social validity of the research conducted by Freeman-Green et al. (2015), students knew how to start solving mathematical problems and how to work on the problems by using the Solve It! strategy. The findings of the mentioned study support the findings found in this research. As a result of the study, it has been observed that the Modified Solve It! strategy has important social effects and has high social validity.

The Evaluation of The Effectiveness of The Modified Solve It! Strategy In Terms of Its Strategy Aspects

For this research, a five-step strategy was developed by adapting the Solve It! strategy. Cognitive strategy instruction was conducted during the strategy instruction process. The cognitive strategy instruction was criterion-based, and this enabled the researchers to accurately collect and analyze the increase in student performance and facilitated the systematic advance of the student to the next level during the strategy instruction process (Case et al., 2002; Karabulut, 2015). Using a criterion-based instruction method in the study prevented the random independence of the students and made the study more reliable. The main goal of cognitive strategy instruction is the teaching and internalization of the strategy rather than the goal that needs to be achieved (Karabulut & Ozmen, 2018). The following factors enabled the independence of students when they became individuals who were able to use good strategies and who could solve problems well: (a) talking aloud during instruction; (b) providing a routine for the students; (c) using scaffolding and prompts; (d) displaying a detailed model; (e)providing guidance and developing interactive dialogues in order to facilitate the interaction between the teacher and the student; (f) providing corrective feedback and offering prompts when the student needs it (Case et al., 1992). It was observed that talking aloud during all stages of strategy instruction and enabling the students to think out loud during practice enabled the students to internalize the strategy, and this supports the literature (Case et al., 1992; Daniel, 2003; Freeman-Green et al., 2015; Guzel-Ozmen, 2006, 2011; Montague et al., 2014).

The scaffolding in cognitive strategy instruction was developed with special care and integrated into the stages of the Modified Solve It! Strategy during this study in order to enable students to use self-regulation

skills actively and to enable them to internalize the strategy. The scaffolding made it easier for the students to internalize the strategy by making the strategy concrete (Guzel-Ozmen, 2006; Karabulut, 2015). The 'Strategy Observation Sheet 'was used to enable the students to create a routine to use the stages of the strategy (Karabulut, 2015). It was observed that students who used the scaffolding 'Reading Check List' in the 'Read' stage were able to analyze and talk about a problem in the other practice sessions without using this scaffolding. The 'explain' step expected the students to underline key words in the problem. It was observed that students who displayed high performance in underlining key words during the teaching of prerequisite skills did not experience difficulties during this stage and found the key words immediately (Chung & Tam, 2005; Mesler, 2004; Montague, 2000). During the 'Visualize' stage, the schemas were given to the students as different from the Solve It! strategy. The students were asked to fill in the schemas that had been prepared as appropriate to the problems. Marshall (1995) has stated that the schemas are as important as solving the problems. This also proves why the students who forgot to fill in the schemas or filled them in incorrectly during the study process had incorrect answers while solving the problems. Jitendra (2002) has stated that the schemas decrease the cognitive load of the students as well as contribute to the analysis and solution of the problem. It was found out that it was easier for the students to comprehend and decide on the process as the problems were made concrete through visualization. It may be said that the schema directs the students while they understand the problem better and decide what to do in the next step.

The steps 'say it, ask, and check' steps which are part of the strategy are metacognitive strategies which enable the students to internalize the cognitive strategies that they have learned, and enable them to create a routine (Case et al., 1992; Daniel, 2003; Montague, 1992; Montague & Bos, 1986; Ruya-Ozmen & Ozkubat, 2018). Case et al. (1992) have stated that the fact that strategy instruction has become an important teaching approach in teaching problem-solving skills is not merely related to cognitive strategies with a few stages, but that this situation is also related to combining these strategies with self-regulation strategies and using them together. In their study, Case et al. (1992) stated that metacognitive strategies are effective when students internalize the strategy that they have learned. Additionally, these strategies enable them to solve problems more easily and generalize the strategy.

A social validity scale was collected from the families in order to find out whether the students were able to generalize the strategy to home settings as the research was conducted during the pandemic and as the schools were closed during this period. Although the social validity data collected from the families made us believe that the students generalized the strategy to home settings, there is no evidence-based data for this study concerning this. However, there are findings in the literature that have shown that students generalize the strategy to different situations (Karabulut, 2015; Montague, 1992; Whibity, 2015).

While it was observed that students used the metacognitive strategies in the Modified Solve It! strategy effectively, it was also seen that they were not able to use the self-reinforcement skill, which was verbally integrated into the strategy process, effectively. It is thought this is related to the fact that the self-reinforcement skill was not integrated into the steps of the strategy, but was used only verbally during the process. It is believed that adding self-reinforcement to the steps of the strategy will promote the self-reinforcement skills of the students, and thus the student will motivate himself or herself about solving the problem and using the strategy, as well as enabling the student to increase self-motivation. It was observed that the students were able to maintain both metacognitive skills and cognitive skills even after withdrawal. This is also an indicator that shows that the students have internalized the strategy and have created a routine with it (Montague et al., 2014).

It is seen that in the literatüre, problems with addition and problems with subtraction are taught separately (Case et al., 2002; Montague, 1992; Montague et al., 2014). However, in this study problems with addition and problems with subtraction were presented to the students simultaneously in order to shorten the instruction process and facilitate the generalization process. In addition, the student was motivated to solve problems by learning, which prevented the student from managing the process in a rote fashion. Moreover, monitoring data was collected two weeks, four weeks, and five weeks after post-

instruction data, as well as generalization data. On the whole, it was observed that the students maintained their performance. It is believed that presenting metacognitive skills along with strategy instruction has been effective (Case et al., 1992; Cassel & Reid, 1996; Karabulut, 2015).).

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