IOJPE

ISSN: 1300 – 915X
www.iojpe.org

International Online Journal of Primary Education

2021, volume 10, issue 2

EXAMINING THE EFFECTIVENESS OF READER STRATEGY IN INTELLECTUALLY DISABLED STUDENTS' MATHEMATICAL PROBLEM SOLVING

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Received: February 17, 2021 **Accepted:** May 23, 2021 **Published:** December 31, 2021

Suggested Citation:
Karabulut, A., Özkubat, U., & Uçar, A. S. (2021). Examining the effectiveness of reader strategy in intellectually disabled students' mathematical problem solving. *International Online Journal of Primary Education (IOJPE), 10*(2), 397-414.

Abstract

Mnemonic strategies provide information about which steps should be followed respectively while solving students' mathematical problems. The main purpose of this study is to examine the effectiveness of READER problem solving strategy, which is one of the mnemonic strategies, on problem solving performances of students with intellectual disabilities. In the study, the generalization of students' performances in change problems to classification and comparison problems and their ability to maintain this performance were determined. Three students participated in the study and "Multiple Probe Design", one of the experimental designs with a single subject, was used in the study. READER strategy teaching was carried out with the Self Regulation Strategy Development teaching approach. Findings were graphically illustrated and analysed. Research findings showed that the READER strategy was effective in solving change problems for students with intellectual disabilities and that the students who gained this strategy continued their problem solving performance 1, 3 and 5 weeks after the intervention ended. In addition, it was found that students generalized their change problem-solving performances to classification and comparison problem types, and continued their generalized performance even after 2, 3 and 4 weeks. Research findings were discussed within the framework of problem solving literature and theoretical views. Suggestions were also made for future research.

Keywords: READER strategy, math problem solving, SRSD, intellectually disabled.

INTRODUCTION

It is important for students to acquire basic academic skills in order to be successful in their school life and to live independently in the society. It is aimed to provide students with basic academic skills in the school. These basic academic skills can be listed as reading, writing, basic arithmetic operations, and problem solving. It is emphasized that problem solving is at the centre of mathematics education and is one of the main objectives. In this regard, the main objectives of the mathematics curriculum include students' expressing their own thoughts and reasoning in the problem solving process, and developing a self-confident approach to mathematical problems. In addition, problem solving is considered as one of the target behaviors in all of the learning areas of mathematics (numbers and operations, algebra, geometry and measurement, data processing and probability) (National Council of Teachers of Mathematics, NCTM, 2000).

Mathematical problem solving is defined as a complex cognitive activity involving several processes and strategies (Montague, 1992). Students who are competent in problem solving have a repertoire of strategies and can use these strategies appropriately (Karabulut & Özmen, 2018; Özkubat & Özmen, 2020). However, unlike these students, especially students with special needs have difficulties in solving mathematical problems (Özkubat, Karabulut, & Özmen, 2020). Students with special needs have significant difficulties in understanding the problem in general, in determining the important information in the problem, in converting verbal information and numerical information into operations, in applying their previous knowledge effectively when they encounter a situation they have not encountered before, and in using effective strategies for problem solving (Özkubat, 2019). In addition, students with intellectual disabilities often have limitations in the effective use of cognitive and metacognitive strategies while solving math problems (Geary, 2010). The use of cognitive processes and cognitive strategies in problem solving plays a key role from reading the problem to reaching the solution and controlling the solution and process (Rosenzweig, Krawec, & Montague, 2011). Metacognitive strategies are used to regulate the cognitive processes used in solving mathematical problems, to manage these operations and to regulate students' own problem solving performance (Montague, 1992). Thus, process-based teaching is needed to help especially the students with intellectual disabilities who have limitations in both cognitive and metacognitive strategies gain problem solving skills. In process-based teaching, unlike product-based teaching, the focus is not on the accuracy of the result of the problem, but on the problem solving process. In this process, the process is completed by paying attention to the processes and especially to the cognitive and metacognitive strategy used (Montague & Boss, 1986).

There are several studies in which various process-based teaching methods are applied in which the use of cognitive and metacognitive strategies is taught in order to improve the problem solving skills of students with special needs. Mnemonic strategies, diagram-based teaching, and Solve it! can be given as examples to process-based approaches that are effective in solving math problems (Karabulut, 2015). Mnemonic strategies indicate which cognitive steps should be respectively taken while solving students' math problems and are strategies in which the first letters of the strategy are reminders (Reid & Lienemann, 2006). Strategies such as FOPS (Jitendra & Star, 2012); RUN (Fuchs, Powell, Cirino, Schumacher, Marrin, Hamlett, & Changas, 2014); DOTS (Xin & Zhang, 2009); PASS (Iseman & Naglieri, 2011; Kroesbergen & VanLuit, 2003; Naglieri & Johnson, 2000) READER (Mancl, 2011); STAR (Gagnon & Maccini, 2001; Maccini & Hughes, 2000; Maccini & Ruhl, 2000; Özkubat, Karabulut & Uçar2021; Peltier & Vannest, 2016); SOLVE (Freeman-Green, O'Brien, Wood, & Hitt,2015); LAP (Test & Ellis, 2005); FAST DRAW (Tok & Keskin, 2012) are among the strategies that are used to increase the problem solving performance of students with special needs. The schema-based teaching strategy is a strategy that helps students with special needs understand how problems should be placed within diagrams and how to choose the correct action when solving problems (Jitendra, DiPipi, & Perron-Jones, 2002). The effectiveness of schema-based problem solving strategies has been tested in students with learning difficulties ((Alghamdi, Jitendra, & Lein, 2020;, 2020; Griffin & Jitendra, 2009; Jitendra, Hoff, & Beck,1999; Jitendra et al., 2002; Jitendra, Griffin, Haria, Leh, Adams, & Kaduvettoor,2007; Jitendra & Hoff, 1996; Morin, Watson, Hester, & Raver, 2017; Walker & Poteet, 1990; Xin, 2008; Xin, Jitendra, & Deatline-Buchman2005), students with intellectual disabilities (Baki, 2014; Karabulut, Yıkmış, Özak, & Karabulut,2015; Kot & Yıkmış, 2018; Tufan & Aykut, 2018), students with normal development (Jitendra Burgess & Gajria, 2011; Owen & Fuchs, 2002), students with low performance in mathematics (Jitendra et al., 2002), students with autism spectrum disorder (Rockwell, Griffin, & Jones2011) and students with visual impairment (Tuncer, 2009). With schema-based teaching, it is stated that the number of schemas used by students with special needs increased, their level of use of diagrams improved, and they generalized the use of diagrams to different problems (Özkubat, Karabulut & Akçayır., 2021; Powell & Fuchs, 2018). The problem-solving model called “Solve This!” was developed by Montague (1992). This model is consisted of seven cognitive strategies and three metacognitive strategies. While seven cognitive strategies in problem solving are defined as reading, paraphrasing, visualizing, hypothesizing, predicting, calculating, and checking, the cognitive operations used in the process are specified as comprehension, translation, transformation, planning, prediction, calculation, and evaluation. Metacognitive strategies are listed as self-instruction, self-questioning, and self-monitoring, while metacognitive operations are described as the knowledge, use, and control of strategy (Montague, 1992). Research conducted with students with learning difficulties have shown that Solve It!, which is a strategy used for improving students' problem solving performances, is an effective strategy (Daniel, 2003; Krawec, Huang, Montague, Kressler, & De Alba, 2013; Montague, 1984; Montague, 1992; Montague & Bos, 1986; Montague, Enders & Dietz, 2011; Montague, Krawec, Enders & Dietz, 2014). It is seen in research that Solve It! strategy is taught with a clear expression by following the stages of modelling, thinking aloud, guided, and independent intervention, and generalization. When all research results are examined, it is emphasized that the cognitive and metacognitive strategies applied in the problem solving process improve the mathematics skills of students with learning difficulties. Effectiveness results obtained in research with students with learning difficulties have shown that Solve It! strategy increases the problem solving performance of students with other types of disabilities such as autism spectrum disorder (Whitby, 2012), mental disability (Chung & Tam, 2005; Karabulut & Özmen, 2018) and spina bfida (Coughlin & Montague, 2011). Research conducted with students with autism spectrum disorder, those affected by mental disability, and spina bfida has demonstrated that Solve It! is an effective strategy (Chung & Tam, 2005; Coughlin & Montague, 2011; Whitby, 2012). In the literature, in order to improve the mathematical problem-solving skills of students with special needs and increase their performance, in addition to process-based teaching approaches in mathematics problem solving teaching, concrete-semi-concrete-abstract problem-solving approach (Butler, Miller, Crehan, Babbitt, & Pierce,2003; Hunt & Vazquez, 2014; Maccini & Hughes, 2000; Maccini & Ruhl, 2000; Scheuermann, Deshler, & Schumaker, 2009; Strickland & Maccini, 2012) and problem-based learning approach (Bottge & Cho, 2013; Bottge, Ma, Gassaway, Toland, Butler & Cho,2014; Bottge, Rueda, Grant, Stephens, & Laroque, 2010; Bottge, Rueda, LaRoque, Serlin, & Kwon, 2007) are also used (Özkubat et al, 2021b).

In process-based approaches, in mnemonic strategies, students can be taught which steps should be applied to solve their mathematical problems, respectively (Montague & Boss, 1986). One of these strategies is READER strategy, the effectiveness of which is examined in this study. READER strategy, developed by Mancl (2011), is taught with the help of mnemonics consisting of the initial letters of strategies (READER / Read the problem-Examine the question information-Abandon irrelevant- Determine the operation, using the diagrams if needed- Enter the numbers- Record the answer). It is stated that the READER strategy is effective for students with special needs because it specifies the steps to be taken in problem solving in order (Mancl, 2011). Each letter of READER Strategy points to a cognitive strategy step. Table 1 shows the main and intermediate steps of READER strategy.

Table 1. READER strategy steps

Mnemonics	Strategy Steps
R	Read the problem.
E	Examine the questions.
A	Abandon irrelevant information.
D	Determine the operation using the diagrams, if needed.
E	Enter numbers.
R	Record answer.

In READER strategy, in the read the problem step, the student is aimed to understand the problem; in the step of examining the information contained in the problem, the student determines the relevant and irrelevant information contained in the problem before solving the problem; in the step of abandoning the irrelevant, the student is aimed to be able to distinguish the information that is not included in the solution of the problem and is considered unnecessary; in determining the operation step, the students decides on the basic arithmetic operation to be used by expressing the problem visually (pictorial); in entering the numbers step, the student uses the numbers that will lead the student to a solution; in the record the answer step, the student records the answer using the mathematical expressions included in the problem (Mancl, 2011).

In this research, READER strategy teaching was carried out with the Self-Regulated Strategy Development (SRSD) teaching approach (Harris & Graham, 1992). This approach is frequently preferred for students with special needs to gain academic skills and to improve their existing academic skills and can be used together with cognitive strategy teaching (Case, Harris, & Graham, 1992; Cassel & Reid, 1996; Chung & Tam, 2005; Graham & Harris, 2003; Hutchinson, 1993; Maccini & Hughes, 2000; Montague, Applegate, & Marquard,1993; Karabulut & Özmen, 2018; Sanders, Losinski, Parks Ennis, White, Teagarden, & Lane,2019). This approach involves the basic components of all cognitive strategy teaching routines. The six stages included in the approach are defined as: a) activating prior knowledge for the implementation of strategies and procedures required for problem solving, b) discussing the strategy considering the students' current performance, explaining the strategy, and describing how these strategies will help students increase their problem solving skills, c) modelling by using think-aloud in the problem solving process, d) memorizing the strategy steps and expressions used by students for self-regulation, e) supporting the use of strategies by practicing appropriate examples, f) completing the mathematical problem solving process by using self-regulation strategies independently (Montague & Dietz, 2009).

When the studies in national literature to support the problem solving performance of students with special needs are examined, it is seen that schema-based teaching strategy was used in students with intellectual disabilities (Baki, 2014; Karabulut et al., 2015; Kot & Yıkmış, 2018; Tufan & Aykut, 2018) and students affected by visual impairment (Tuncer, 2009), Solve It! teaching strategy is used in students with intellectual disabilities (Karabulut, 2015; Karabulut & Özmen, 2018) and students with learning difficulties (Gencan, 2020), mnemonic strategies are used in students affected by mental disability (Özkubat et al., 2021). At this point, it can be said that there are a limited number of studies examining the effects of different problem-solving interventions among the studies conducted to support the mathematical problem-solving skills of students with intellectual disabilities in our country. Moreover, there is a similar situation when the national literature is examined in terms of Self-Regulation Strategy Development teaching approach, which is used together with cognitive strategy teaching in teaching problem solving skills to students with mental disabilities (Karabulut, 2015; Karabulut & Özmen, 2018). For this reason, it is thought that READER mnemonic strategy teaching, which was examined in this study, will both increase the quantity of problem solving research in the field of special education and offer a different perspective on teaching problem solving to researchers and practitioners by using the Self-Regulation Strategy Development teaching approach in teaching problem solving skills. In this regard, the general purpose of this research is to determine the effectiveness of READER strategy in problem solving skills of students with intellectual disabilities. In line with this general purpose, answers are sought for the following questions:

1. Is the READER strategy effective in solving change problems for students with intellectual disabilities?

2. After teaching with the READER strategy, do students with intellectual disabilities maintain their change problem solving performance after 1, 3, and 5 weeks?

3. After teaching with the READER strategy, can students with intellectual disabilities generalize their performances in change problems to classification and comparison problems?

4. After teaching with the READER strategy, do students with intellectual disabilities maintain their classification and comparison problem solving performances after 2, 3, and 4 weeks?

IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education
2021, volume 10, issue 2

METHOD

Participants

The participants of the study consist of three students affected by intellectual disability. Some prerequisites and skills were determined for the selection of the participants in this study. Participants are required a) to be diagnosed with intellectual disability by the relevant state or university hospitals, b) not to have an additional disability such as visual, hearing and physical disability, c) to perform two-digit addition with carrying and two-digit subtraction with borrowing at an accuracy of at least 80%, d) to be able to correctly solve at least one and at most three of the change problems including 10 addition and subtraction operations on average, e) to have their parents' consent to participate in the research.

In order to determine the participants, firstly, special education classroom teachers were interviewed. In this interview, information was obtained from the teachers about the performances of students in addition-subtraction operations and problem solving. Secondly, as a result of the evaluation of the obtained information, seven students were found to be eligible for the prerequisite evaluation. Thirdly, the precondition evaluation session was held to evaluate whether these students had prerequisite skills or not. As a result of the evaluation, two students were not included in the study because they could not perform two-digit addition with carrying and two-digit subtraction with borrowing according to the specified criteria, and two students could not solve change problems in the specified criteria. As a result, it was decided to include three students in three different primary school special education classes of the same school as participants. Information about the participants is presented in Table 2.

Table 2. Demographic information of participants

Participants	Gender	Age	Intelligence Department Score	Disability Type
Participant 1	Male	10 years 4 months	65	Intellectual Disability
Participant 2	Male	10 years 9 months	68	Intellectual Disability
Participant 3	Male	10 years 6 months	67	Intellectual Disability

Practitioners

Two of the practitioners have a doctorate degree from the Department of Special Education, and one is at the dissertation stage. Practitioners have publications on mathematics problem-solving interventions applied to students with special needs (Karabulut, 2015; Karabulut et al., 2015; Karabulut & Özmen, 2018; Karabulut & Özkubat, 2019; 2021; Özkubat, 2019; Özkubat & Karabulut, 2021; Özkubat et al., 2020; Özkubat et al., 2021a, 2021b; Özkubat & Özmen, 2018; Özkubat & Özmen, 2020). In addition, the researchers took courses on Cognitive Strategy Teaching during their doctoral education.

Environment and Time

The intervention process of the research was carried out in the library within the school. A tape recorder was used to record all sessions of the research and to calculate observer and practice reliability. All sessions were held by the first author between 12.00-13:30 am on weekdays.

Dependent and Independent Variable

The dependent variable of this research is the percentage of solving change problems involving one-stage addition or subtraction. The independent variable of the research is the READER strategy.

The Experiment Process

The experiment process of the research is composed of five stages: a) baseline sessions, b) instruction sessions, c) post-instruction evaluations, d) generalization, and e) monitoring phases. The stages of the experiment process are explained below.

Baseline sessions

In baseline sessions, which is the first stage of the research, the performances of the participants in solving change problems including one-stage addition or subtraction processes were determined. In this process, students were given and asked to solve 10 one-stage worksheets consisting of change problems, including addition or subtraction. By evaluating the worksheets, the students' baseline performances were calculated as a percentage and plotted on the chart.

Instruction sessions

Instruction sessions were started with the participants who obtained stable data at the baseline sessions. The instruction sessions were continued until the students solved change problems that included one-stage addition or subtraction operations with the READER strategy with 90% accuracy and showed stable data. Teaching sessions were designed according to Self-Regulation Strategy Development. Instruction sessions consist of six stages: a) activating prior knowledge, b) discussing the strategy, c) modelling, d) memorizing the strategy, e) guided practices, and f) independent practices. In the stage of activating the prior knowledge, the key words (left, increased, decreased, spent, etc.) were provided to the students to help them use the strategy effectively while solving the problem. At the stage of discussing the strategy, explanations were made about the benefits of using the strategy, the fact that the READER strategy enables solving mathematical problems and reminds numerical skills and general problem solving steps, and the READER strategy consists of six steps and what these steps are. Where and how to use the READER strategy steps were explained, and whether they would be useful in the problem solving process was discussed with the participants. In the stage of modelling, when and how to use the strategy steps, thinking out loud, interactional dialogues were used as a model. At the beginning of the session, 10 worksheets containing change problems including one-stage addition and subtraction were introduced to the student. In the worksheets, each problem is placed in the READER strategy form in the annex (Appendix 1). For the first step of the strategy, the worksheet was given to the student and the student was asked to read the first problem. Then, the student was asked to put a plus on the read the problem stage in the prepared form. Then he was asked to examine the information contained in the problem. At this stage, the practitioner guided the student and enabled him to focus on the important information in the problem. Then, in the same way, the student was asked to put a plus sign in the review the information box in the READER form. In the next step, the student was asked to abandon unnecessary information in the problem. Unnecessary information in the question was removed under the guidance of the practitioner and a plus sign was placed in front of the relevant item in the form. Then, the operation to be carried out for the solution of the problem were determined and if necessary, a figure was drawn and written in front of the relevant item in the form. Then, the student was asked to enter the numbers that he will use in the operation he will perform in front of the record stage. In the last stage, the student was asked to record the result, on the record the answer box in the form, by performing the operation. At the stage of memorizing the strategy, the six steps of the READER strategy were recited by the student in order. In the guided practices stage, when the student needed help in strategy steps, the practitioner provided guidance. During the instruction sessions, the practitioner guided the student at each step, and explained the steps of the strategy again at the points he was stuck. In each step, the correct responses of the student were reinforced. If the student gave incorrect answers or was unresponsive, the practitioner provided verbal cues and the student was able to reach the correct answers. During the independent practices stage, the student was given the opportunity to independently implement the strategy steps. The student was expected to remember the strategy and fulfil the criteria for implementation in order to pass from one stage to the next. This stage continued until the student used the strategy competently and increased the number of correct problem solving to 9 or more. Ten worksheets consisting of one-stage change problems including addition or subtraction were used in the instruction sessions. After the instruction sessions, the post- instruction evaluation session was started. Teaching sessions, conducted as described, consisted of 11 sessions in total: one session to activate prior knowledge for each participant, one session to discuss the strategy, four sessions for modelling, one session for memorizing strategy, two sessions for guided practices, and two sessions for independent practices.

Post-instruction evaluation

In the post- instruction evaluation sessions, the process performed in the baseline sessions was followed. The students were asked to solve 10 worksheets consisting of change problems including one-stage addition or subtraction. Then, the worksheets were evaluated, and the students' post-instruction evaluation performances were calculated as a percentage. When the 90% accuracy level, which is the criterion determined for each student, was reached and stable data was obtained in three consecutive sessions, the instruction and post- instruction evaluation sessions were terminated, and the process sessions were repeated for the next student in the same way.

Generalization sessions

Generalization sessions were held to determine the level of generalization of students' performances in change problems to classification and comparison problems. Generalization data were collected by pre-test and post-test data before teaching. During the process of collecting the generalization pre-test data, students were given worksheets consisting of 10 classification and 10 comparison problems including addition or subtraction, and they were asked to answer the questions. The answers given by the students were evaluated and the correct answer percentages were determined and graphed. Generalization data were collected once for the classification problem for the first participant and once for the comparison problem, twice for both problem types for the second student and three times for both problem types for the third participant. After the completion of the one-stage change problem solving instruction with READER strategy, one session generalization instruction was given for the problem types to be generalized, and the post-test sessions were started immediately after. In the post-test sessions, as in the pre-test sessions, the students were given worksheets consisting of 10 classification problems and 10 comparison problems, and they were asked to answer the questions. The answers given by the students were evaluated and the correct answer percentages were determined and graphed.

Monitoring sessions

Following the completion of the instruction, monitoring sessions were initiated. In the monitoring sessions, it was aimed to determine the students' level of maintaining the READER strategy 1, 3 and 5 weeks after the completion of the instruction. In these sessions, they were asked to solve 10 one-stage addition or subtraction problems in the worksheets similar to the post- instruction evaluation sessions. Monitoring sessions were held for each student in the determined weeks, monitoring data was collected, and the correct response percentages were graphed.

Following the generalization sessions

Generalization monitoring sessions were initiated. In the generalization monitoring sessions, it was aimed to determine the students' level of maintaining their generalized problem solving performances 2, 3 and 4 weeks after the completion of the generalization sessions. In these sessions, they were asked to solve worksheets consisting of 10 one-stage addition or subtraction operations and 10 comparison problems similar to generalization sessions. Afterwards, the worksheets were evaluated and the performance of the students to continue generalization was calculated as a percentage, and they were entered in the generalization monitoring data section of the graph. A generalization monitoring session was held for each student in the specified weeks, data was collected, and the percentage of correct answers was graphed.

Data Analysis

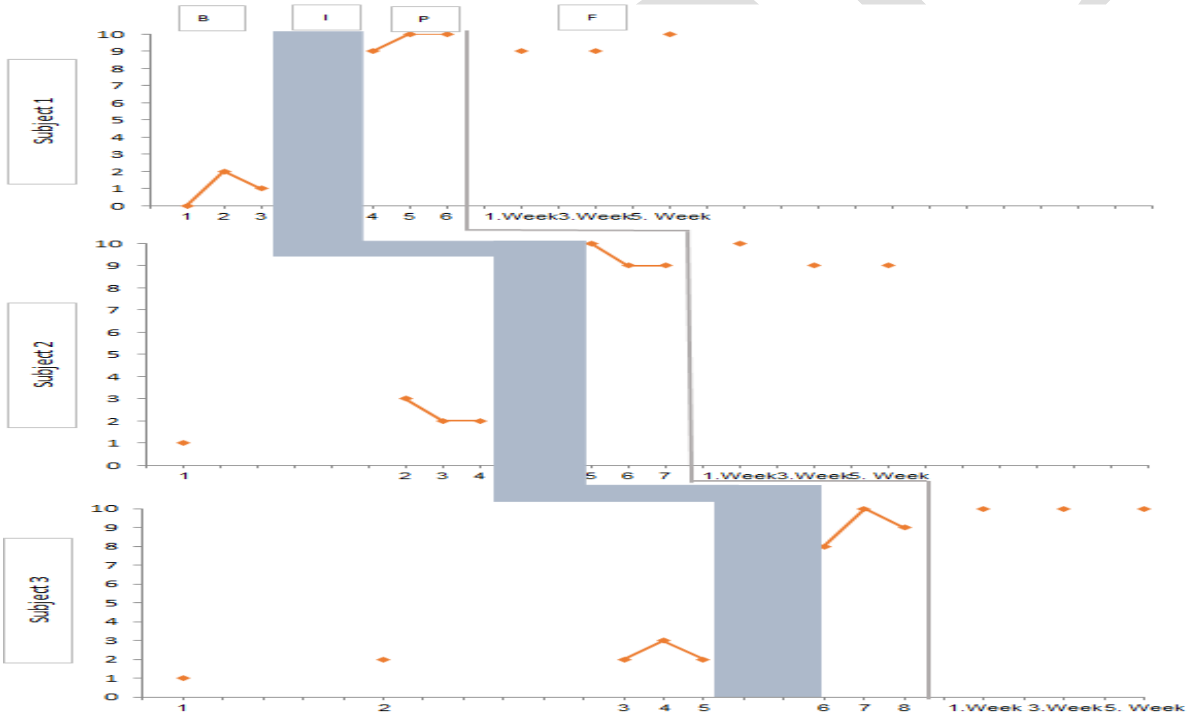
In this study, students' data on change problem-solving, data on maintaining their change problem-solving performance, data of generalizing their performances to classification and comparison problems, and classification and comparison problem-solving data were shown with a line graph and analysed graphically. The graph shows the number of sessions on the horizontal axis and the number of correct answers on the vertical axis. The increase in the level of the data at the end of the intervention of the independent variable according to the baseline level revealed the effect of the applied strategy. The monitoring data were compared with the end-of- instruction data, and it was determined whether there was a difference in level.

Inter-Observer Reliability and Intervention Reliability

Inter-observer reliability calculation was made by dividing the total consensus of the researcher and the observer by the sum of the consensus and divergence and multiplying by 100 (House, House, & Campbell, 1981). The observer is a research assistant with a doctorate in special education. The observer was told how to score the data and asked to evaluate participants’ answers to the problems as wrong or correct and fill in the Observer Reliability Registration Form by marking Yes or No columns. Accordingly, the inter-observer reliability for each of the three participants was found to be 100%. Intervention reliability was calculated by dividing the observed researcher behaviour by the planned researcher behaviour and taking the percentage (Billingsley, White, & Munson, 1980). Accordingly, the intervention reliability for each of the three participants was found to be 100%.

RESULTS

The baseline, post- instruction and follow-up findings of the participants' levels of solving change problems that include one-stage addition and subtraction are shown in Graph 1.



B: Baseline, I: Instruction, P: Post Instruction, F: Follow-up

Graph 1. The baseline, post-instruction and follow-up findings regarding the subjects' solving levels of change problems including one-stage addition and subtraction

While the first participant gave correct answers to an average of 1 problem, at least 0 and at most 2, out of 10 change problems involving three consecutive sessions of addition or subtraction at the baseline level, at the end of the READER strategy teaching, he gave correct answers to an average of 10 problems, with a minimum of 9 and maximum of 10. In post- instruction follow-up sessions, he gave correct answers to 9 problems one week later, 9 after three weeks and 10 problems after five weeks, respectively. The second participant gave correct answers to an average of 2 problems, at least 1 and at most 3, out of 10 change problems involving addition or subtraction in four sessions at the baseline level. The attendance data obtained at the beginning of the experimental process and the baseline data obtained before starting the instruction did not differ. At the end of the READER

IOJPE
ISSN: 1300 – 915X
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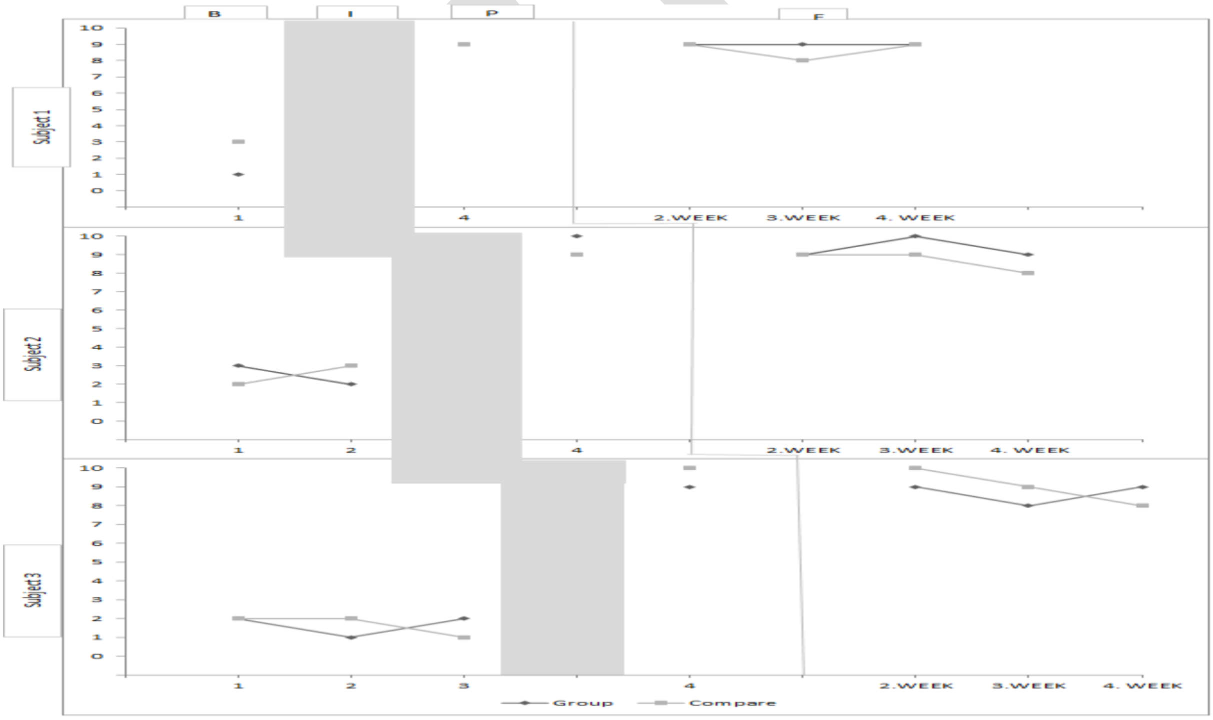
International Online Journal of Primary Education 2021, volume 10, issue 2

strategy teaching, he gave correct answers to an average of 9 problems, with a minimum of 8 and a maximum of 10. In post- instruction follow-up sessions, he gave correct answers to 10 problems one week later, 9 after three weeks, and 9 problems after five weeks, respectively. The third participant gave correct answers to an average of 2 problems, at least 1 and at most 3, out of 10 change problems that included addition or subtraction in five sessions at the baseline level. At the end of the READER strategy teaching, he gave correct answers to an average of 9 problems, with a minimum of 8 and a maximum of 10. The participant gave correct answers to all problems in the follow-up sessions held one, three and five weeks after the instruction. As a result, there is a difference between the number of correct answers given by all three participants to the problems involving one-stage addition and subtraction at the end of the READER strategy teaching and the baseline level. As seen in Graph 1, the level of the data path obtained at the end of the instruction is higher in all participants compared to the baseline level. All three participants met the 90% accuracy criteria determined at the end of the instruction. This progress was not observed before the intervention of the independent variable but was observed after the intervention of the independent variable. For this reason, the READER strategy was found to be effective in solving change problems involving one-stage addition and subtraction. In addition, there was no decrease in the follow-up sessions after the instruction compared to the end of the instruction. This finding shows that the READER strategy is effective in maintaining the performance of participants in change problems involving one-stage addition and subtraction after 1, 3, and 5 weeks.

The findings before and after the instruction regarding the classification and generalization levels of the participants' performance of solving change problems including one-stage addition and subtraction process to comparison problems are shown in Graph 2.



B: Baseline, I: Instruction, P: Post Instruction, F: Follow-up

Graph 2. Generalization level of participants' performance of solving change problems including one-stage addition and subtraction to classification and comparison problems involving one-stage addition and subtraction.

While the first participant gave correct answers to 1 out of 10 classification problems that included one-stage addition and subtraction during the generalization pre-test stage, after the READER strategy and an instruction session generalization instruction were applied, he gave correct answers to 9 problems. In the generalization follow-up sessions held after the instruction, he gave correct answers to 9 problems after two weeks, 9 after three weeks and 9 after four weeks, respectively. There was no decrease in the number of problems that the participant solved in the generalization follow-up sessions compared to the end of the instruction. Likewise, while he gave correct answers to 3 out of 10 comparison problems including one-stage addition and subtraction during the generalization pre-test phase, after the READER strategy and a generalization instruction were applied, he gave correct answers to 9 problems. In the post-instruction generalization follow-up sessions, he gave correct answers to 9 problems after two weeks, 8 after three weeks and 9 after four weeks, respectively. There was no decrease in the number of problems that the participant solved in the generalization follow-up sessions compared to the end of the instruction. While the second participant gave correct answers to at least 2 and at most 3 of the 10 classification problems in the generalization pre-test phase, which includes one-stage addition and subtraction, after the READER strategy and a generalization instruction were applied, he gave correct answers to all of the problems. In the post-instruction generalization follow-up sessions, he gave correct answers to 9 problems after two weeks, 10 after three weeks, and 9 after four weeks, respectively. Compared to the end of the instruction, only an average of 1 problem decreased in the number of problems solved by the participant in the generalization follow up sessions. Similarly, while he gave correct answers to at least 2 at most 3 out of 10 comparison problems that include one-stage addition and subtraction in the generalization pre-test phase, after the READER strategy and a generalization instruction were applied, he gave correct answers to 9 problems. In the generalization follow-up sessions held after the instruction, he gave correct answers to 9 problems after two weeks, 9 after three weeks and 8 problems after four weeks, respectively. Compared to the end of the instruction, only an average of 1 problem decreased in the number of problems solved by the participant in the generalization follow up sessions. While the third participant gave correct answers to at least 1 and at most 2 of 10 classification problems that include one-stage addition and subtraction in the generalization pre-test phase, he gave correct answers to 9 problems after the READER strategy and a generalization instruction were applied. In the post-instruction generalization follow-up sessions, he gave correct answers to 9 problems after two weeks, 8 after three weeks and 9 after four weeks, respectively. Compared to the end of the instruction, there was no decrease in the number of problems that the participant solved in the generalization follow-up sessions. Similarly, while he gave correct answers to at least 1 at most 2 out of 10 comparison problems that include one-stage addition and subtraction at the generalization pre-test phase, he gave correct answers to all problems after the READER strategy and a generalization instruction were applied. In the post-instruction generalization follow-up sessions, he gave correct answers to 10 problems after two weeks, 9 after three weeks, and 8 problems after four weeks, respectively. Compared to the end of the instruction, in the generalization follow-up sessions, there was only an average of 1 problem decreased in the number of problems solved by the participant. As a result, there is a difference between the pre-test and post-test data of all three participants. At the end of the instruction, the participants reached an accuracy level between 90% and 100% in solving classification and comparison problems. Therefore, students with intellectual disabilities who participated in the study generalized their problem solving performance in change problems to solving classification and comparison problems.

In conclusion, this research has shown that READER strategy is effective in solving change problems involving one-stage addition and subtraction for students with intellectual disabilities, and students who have gained READER strategy continue to use these strategies after the intervention is completed. In addition, in this study, it was revealed that with the READER strategy, students with intellectual disability generalize both the problem solving performance and the strategy performance they have shown in change problems involving one-stage addition or subtraction to different types of problems and maintain their generalized performance.

DISCUSSION and CONCLUSION

In the present study, it was investigated whether the READER strategy was effective in students with intellectual disabilities in solving change problems involving one-stage addition or subtraction, generalization of students' performances in change problems to classification and comparison problems, and their performance in maintaining these performances. Findings obtained from the research show that the READER strategy used in this study is effective in students' problem solving, that students can generalize their performance to different problem types and maintain their performance. In the literature, READER strategy has been tested only on students with learning difficulties and its effectiveness has been found (Mancl, 2011). In this study, READER strategy was found to be effective in students with intellectual disabilities. In this respect, the research results are consistent with the results of the research conducted by Mancl (2011).

Studies conducted on how students solve mathematical problems show that students solve mathematical problems by using their own solutions in the first and second grades (Cawley, Parmar, Yan, & Miller1998; Ginsburg, 1997). However, when students reach the secondary school level, it is observed that they abandon their personal problem solving strategies and start using the problem solving strategies they learned at school (Romberg, 1993). At the secondary school level, students tend to operate automatically with the numbers included in the problem. In this context, teaching strategies for solving mathematics problems are especially effective for secondary school students (Montegue, 1997). In this respect, the effectiveness of the READER strategy used in this research is an expected finding that is consistent with the literature.

READER strategy shows the steps students will follow while solving the problem, as well as focusing on the cognitive strategies to be used at each step and the metacognitive strategies used for the students to monitor and control themselves during the problem solving process. Knowing these steps is important for students with intellectual disabilities who have limitations in managing their own learning process and cognitive processes in order to be a good problem solver (Karabulut, 2015). Self-monitoring was used as a metacognitive strategy in this study. Self-monitoring helps students to follow the steps of the strategy accurately and completely, and to follow which task to do in which step while solving problems, thus helping them to control themselves (Montague, 2007). In this regard, self-monitoring helped the participants in this study to easily monitor whether the strategy steps used in problem solving were implemented, self-control and evaluation, and learn the strategy steps. It is thought that this situation is effective in increasing the strategy experience of the participants. The increase in strategy performances, on the other hand, played a key role in generalizing their problem solving performances to different environments and different problems, and in their permanent performance. In addition, the supporters used in cognitive strategy teaching were included in this study to help participants become independent in the strategy. This is the READER strategy tracking sheet that contains the stages of the READER strategy. The sheet helps the student monitor himself and learn strategy steps by marking the steps he went through while solving problems.

One of the reasons for the READER strategy to be effective in the study is thought to be the Self-Regulation Strategy Development (SRSD) teaching approach used in the instruction. It is stated that there are certain reasons why this teaching approach is frequently used in students (Graham & Harris, 2003). Firstly, it can be shown that this strategy has emerged as a result of years of research and has been used effectively for nearly 20 years (Graham & Harris, 2003). Secondly, the strategy has an overarching feature that focuses on the cognitive, motivational, and academic characteristics of students with learning difficulties. In this context, Self-Regulation Strategy Development includes basic information in the context of providing metacognitive information on strategies to be applied to students with academic limitations and with special needs and making information processing more efficient. The third reason is that different self-regulation strategies (self-monitoring, self-instruction, self-reinforcement, and goal setting) can be used together in the teaching approach. It is stated that using these strategies together is more effective. The fourth and last reason is that this approach can be applied by classroom teachers in accordance with classroom teaching (Graham & Harris, 2003). The main purpose of this teaching approach, whose advantages are stated, is to train students who are self-regulated (Reid & Lienemann, 2006). To achieve this, cognitive and metacognitive strategies should be combined with appropriate self-regulation strategies and applied in coordination (Reid & Lienemann, 2006). For these reasons, it is thought that the presentation of the READER strategy according to the SRSD stages has a significant role in the ability of students with intellectual disabilities to apply these steps, thus increasing the number of correct problems they solve.

In the teaching approach of SRSD, being a model is especially important for the success of teaching (Karabulut & Özmen, 2018; Montague & Dietz, 2009). Cognitive modelling is generally used as a model for the process by using think aloud protocols while applying a cognitive activity (Montague & Dietz, 2009; Özkubat & Özmen, 2018). At this stage, the implementer becomes a model for how strategic learners or master problem solvers think and act when faced with an academic task. With this technique, students have the chance to learn by imitation, and observe and hear how master problem solvers understand the problem, analyses the problem, develop a solution plan to solve the problem, complete the task, and evaluate the result (Montague & Dietz, 2009). In this study, it was observed that the participants included thinking aloud, which they did not include at the baseline level while solving the problem, in the guided practices and the independent practices stages. These observations show that the participants have started to internalize the strategy. In addition, the participants expressed that they were happy to use the strategy and they were satisfied with the problem solving by using this strategy. For example, participants gave self-regulation expressions such as ‘I know what to do while solving problems, problem solving is easy for me now.” Although these statements are not included as a direct purpose in this study, they give clues about their social validity.

In the study, it is thought that one of the reasons that READER strategy is effective in mathematical problem solving skills is the visualization strategy. The fourth stage of the READER strategy involves the use of drawings and / or diagrams when deciding operations related with visualization (Mancl, 2011). In fact, there are research findings in the literature to support this data (Gersten, Chard, Jayanthi, Baker, Morphy, & Flojo, 2009; Ives, 2007; Jitendra et al., 2002; Van Garderen 2006). In this respect, the visual aids (pictures, drawings, etc.) used in problem solving can increase the level of understanding the problem by bringing together the information contained in the problem (Ives, 2007; Van Garderen, 2007). It provides a way for students to understand problems visually and solve them correctly (Ives, 2007; Van Garderen, 2007). With the implementation of the curriculum including the visualization strategy, it was found that students with learning difficulties increased the number of diagrams they use in the problem solving process, their level of using the diagrams improved, they generalized the use of diagrams to different problems (Van Garderen, 2007), and they performed better in solving problems (Jitendra et al., 2002). Visualization emerges as a useful strategy in drawing the student's attention to the problem, organizing the student's existing knowledge, and associating the concrete statements and abstract expressions in the problem (Ives, 2007; Karabulut & Özmen, 2018).

In the current study, it is a fundamental limitation that students and teachers' opinions about the strategy are not determined after READER strategy teaching is completed in order to obtain social validity data. At this point, a social validity questionnaire was created by the researchers, but the last sessions of the intervention process coincided with the transition period of the schools to the summer holiday, so it could not be applied due to time limitations. Based on the research findings, there are suggestions for education, practice, and further research. In this study, the READER strategy was found to be effective in the ability of students with intellectual disabilities to solve mathematical problems. Within the framework of this finding, it is recommended that teachers who work with intellectually disabled students use the READER strategy while teaching problem solving skills. In order to increase the generalizability of the research findings, the research can be repeated especially with participants with learning difficulties, different problem types, participants in different educational environments and different researchers. At the same time, the effect of READER strategy on the problem solving skills of students with intellectual disabilities can be analysed by creating a teaching package that includes self-regulation strategies, self-instruction, self-assessment, and self-reinforcement. In addition, the scope of the research can be expanded by adding variables related to the problem solving performances of students with intellectual disabilities and their perception of performance towards mathematics, and their attitudes towards mathematics and mathematical problem solving.

Acknowledgments

The approval of the ethics committee of the study was completed with the decision of Anadolu University Social and Human Sciences Scientific Research and Publication Ethics Committee dated 08.10.2021 and numbered 136084.

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Appendix 1. READER Worksheet

Problem: Jack is a talented student in his art class. His art teacher likes Jack's paintings very much. Jack lost 4 of the 10 crayons he used in painting class. How many crayons does Jack have left?	
Read the problem.	✓
Examine the questions.	✓
Abandon irrelevant information.	~~Jack is a talented student in his art class. His art teacher likes Jack's paintings very much.~~ ✓
Determine the operation using the diagrams, if needed.	I will do the subtraction. ✓
Enter numbers.	10 4 - ____ ✓
Record answer.	10 4 - ____ 6 ✓