

# Improving Student's Mathematical Problem-Solving Skills Through Relating-Experiencing-Appling-Cooperating-Transferring Learning Strategy and Graphic Organizer

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## ABSTRACT

This study aimed to (1) improve student's mathematical problem-solving skills and (2) know student's responses of the implementation of Relating-Experiencing-Appling-Cooperating-Transferring (REACT) learning strategy with graphic organizer. This type of research is a classroom action research (CAR) which conducted in three cycles. The subjects of this study were 38 students of VIII-14 class SMP Negeri 2 Singaraja. Student's problem-solving skills data were collected by using problem-solving tests and student's responses were collected by using questionnaires. The data that have been collected was analysed descriptively. The results showed that the stages of REACT learning strategy and a graphic organizer that used during the learning process can improve student's mathematical problem-solving skills. The improvement can be seen from the increased average score of student's mathematical problem-solving skills from 29.1 in the initial reflection and continued to increase to 69.5 in the last cycle, learning completeness also increased from 5.26% on initial reflection and increased to 81.58% in the last cycle as well as average score of student's responses that were collected through questionnaires was in positive category.

**Keywords:** *Problem-solving skills, REACT, classroom action research, questionnaires*

## 1. INTRODUCTION

Problem-solving skills have a very important position in mathematics education [1]. The purpose of learning mathematics is that students are able to use their ability and knowledge of mathematics to solve problems given in the classroom or in their everyday life. Classroom learning is designed so that schools can provide meaningful learning experiences to students. As an effort to improve student's mathematical understanding, learning activities conducted in the classroom refers to mathematical tasks that have the potential in providing an intellectual challenge for students [2]. The mathematical tasks are the provision of problems that are able to assist students in understanding and applying mathematical concepts, so with the problem-solving activities in learning mathematics can provide an opportunity for students to strengthen and expand the construction of student's knowledge.

Problem-solving skills are an important component of the skills that students need in processing data or information from non-routine problems they get with susceptibility [3]. In accordance with the results of observations on the students of VIII-14 class on SMP Negeri 2 Singaraja, problems arose when the teacher gave the student contextual problems that related to the mathematical concepts which they studied. Complex mathematical problems usually come from a combination of mathematical concepts and problem-solving strategies that are usually difficult for students [4]. The result was the students have not been able to apply the mathematical concepts they have been learned to solve the problem.

Initial tests were then performed as a first step to determine student's abilities. The given essays test consisting of contextual problems that related to the learning materials which had been studied by the students. From the range of values 0 - 100, the average student's score was 29.1,

according to the initial test results, the students were only able to rewrite the information that they get but were unable to make an appropriate problem-solving plan and apply the right mathematical concepts in solving the problem. Understanding the problem only is not enough, but students should be able to see the appropriate mathematical concepts, proper calculation procedures and applying them [5].

The lack of student problem-solving skills is also reinforced by interviews and questionnaires conducted by the math teacher in the class. The result was the mathematics learning in that class was still focused on the explanation of mathematical concepts as well as examples of questions discussed more emphasis on numeracy skills and systematic mathematical procedures. This caused the students less to contribute in constructing their understanding and lack of experience in applying mathematical concepts in real-world problems. The lack of learning settings and real-world problems has a negative impact on student's math problem solving skills [6]. The effectiveness of teaching such as the teacher should be knowledgeable in both the subject they teach and the pedagogy they use in class are determining the student's success in mathematics [7]. but in classroom learning, students are less active in giving their opinions, both in answering questions from teachers and asking about learning materials which they did not understand. Based on these problems, it is necessary a learning strategy that can foster student activeness, assist students in constructing knowledge and applying that knowledge in real life problems. Learning strategy that can be applied is REACT learning strategy.

The REACT learning strategy is a contextual learning strategy that gives students the opportunity to construct new knowledge based on their experience and beliefs [8]. Result from research study of young children show that the foundation of mathematical learning in school was formed from their early experiences with numbers at home or in early mathematical learning settings [9]. The application of REACT learning strategy in this research was assisted with graphic organizer as an answer sheet that allows students to arrange the information obtained visually. Graphic organizer that used is four corners and a diamond graphic organizer that adjusted to Polya's problem-solving steps [10].

had used a graphic organizer in the research of student's problem-solving skills at Morrison Junior High School [11]. The research gave results that the use of graphic organizers can familiarize students to solve problems in accordance with the correct steps, starting from identifying important information to know the purpose of solving the problem. But in the learning process, students only do problem-solving activities without doing other learning activities. stated that there is no learning without doing activities that provide experience for students that can be

gained from the student's active interaction with the surrounding environment so that other activities such as exploration activities, group discuss activities, and other activities can help students to construct their knowledge [12].

In this study, students used graphic organizer at the stage of experiencing, applying, and transferring. In addition to using the graphic organizer in conducting problem-solving activities, learning activities on the REACT strategy also provide opportunities for students to be active in classroom learning in constructing their knowledge and applying mathematical concepts in contextual issues during group discussions so that math learning is more meaningful. Based on the description, the researchers intended to conduct research about implementing REACT learning strategy and graphic organizer to improve student's mathematical problem-solving skill.

## 2. LITERATURE REVIEW

There are four important steps that students must do in solving the problem, namely: (1) understanding the problem (understanding the information and problems given), (2) devising a plan (preparing the problem-solving plan according to the appropriate mathematical concepts) (3) carrying out the plan (implementing problem-solving plan in accordance with the problem-solving plan that has been prepared), (4) looking back (reviewing the problem-solving process that has been made) [13].

The REACT learning strategy focuses on contextual teaching and learning which is at the core of the principle of constructivism [14]. constructivism in the most general sense as a modern view of learning that the student constructs their new knowledge and understanding based on their experience and beliefs.

REACT learning strategy is a contextual learning strategy that provides space for students to build their own knowledge [15]. In detail, REACT learning strategy consist of: (1) relating (connecting learning materials with student experience), (2) experiencing (exploration), (3) applying (applying mathematical concepts to contextual problems), (4) cooperating (group discussions), and (5) transferring (transferring knowledge to a new context) [16].

Graphic Organizer gives students the opportunity to manipulate new ideas and see how those ideas relate to familiar concepts and construct visual representations of those relationships [17]. Graphic organizer that used is four corners and a diamond graphic organizer consisting of five areas that adjusted to Polya's problem-solving steps [10]. In these areas, students can write down: the problems they are looking for (main ideas), the information they get (connections), the problem-solving plan (brainstorming), problem-solving (solve), and the conclusions of the solutions (write) [11].

### 3. METHODOLOGY

#### 3.1 Research Procedures

The type of this research is classroom action research (CAR) and in its implementation consisted of three cycles with the subject of research were students of VIII-14 class on SMP Negeri 2 Singaraja in 2017/2018 academic year which amounted to 38 students. As a first step, an initial reflection was conducted which consisted of observation activities, initial test, and questionnaires as well as interviews with the mathematics teacher. The obtained result was that the student's mathematical problem-solving skill was low. Reflecting on the results of initial reflection, researchers then applied REACT learning strategy with a graphic organizer. The procedure used in this CAR is described as a spiral of several cycles along with the stages in each cycle consisting of:

- (1) Action planning: researchers discussed with the math teacher in the class to prepare the learning process.
- (2) Implementation of the action: the learning process in each cycle began with preliminary activities in the form of connecting experiences and contextual issues that relevant to the student's surroundings with the material of subjects (relating), followed by core activities of group discussions and class discussions. During the group discussion, students with their group members worked together on student's worksheet (SW) which was distributed by the teacher (cooperating). Students performed exploration activities, like finding the concept of math through a hands-on activity in the form of object manipulation activities and problem-solving activities in accordance with the steps that exist in SW (experiencing and applying). In problem-solving activities, students used the graphic organizer as an answer sheet. After constructing their knowledge, students learned to apply mathematical concepts to new contexts or new problems with more complex situations (applying and transferring). In this activity, students also used the graphic organizer as an answer sheet that allows students in reviewing the given contextual problems. The core activities ended with class discussions, each group presented the results of the discussion while the other group responding to the results of the group discussion. The learning process ended with concluding activities by concluding learning materials and giving quizzes to students.
- (3) Observation and assessment: observation was performed at each meeting during the learning process. Assessment of student's mathematical problem-solving abilities was performed at the last meeting in each cycle.
- (4) Reflection: reflection was carried out at the end of each cycle to identify constraints gained at the observation and assessment stage and used as a guide for planning the action in the next cycle. There are

four important steps that students must do in solving the problem, namely: (1) understanding the problem (understanding the information and problems given), (2) devising a plan (preparing the problem-solving plan according to the appropriate mathematical concepts) (3) carrying out the plan (implementing problem-solving plan in accordance with the problem-solving plan that has been prepared), (4) looking back (reviewing the problem-solving process that has been made) [18].

#### 3.2 Research Instrument

The type of data in this study is presented in Table 1.

Table 1. Type of Data

Type of Data	Technique	Method	Period
Mathematical problem-solving skills	Test	Test on student's problem-solving skills	The end of cycle I, II, and III
Student's responses to the implementation of the REACT learning strategy	Non-Test	Filling questionnaire of student's feedback	The end of cycle III

#### 3.3 Data Collection Technique

The student's mathematical problem-solving data was obtained from the test result which consisted of four essays that were assessed by the rubric of analytic scoring whose indicators are adjusted to the problem-solving steps as in Table 2.

Table 2. Scoring rubric of mathematical problem-solving skills.

Indicators	Criteria	Score
Understanding problems	Rewrite the information that is known and stated correctly	2
	Rewrite the information that is known and asked but it is wrong	1
	Not rewrite the information that is known and asked	0
Planning the problem solving	Make complete and correct completion steps	3
	Make the completion steps correctly but still incomplete	2
	Make the completion steps but incorrect	1

	Not writing down the completion steps	0
Completing the problem-solving plan	Perform calculations according to the right plan and systematic and get the right results	5
	Performing calculations according to the right plan and systematic but get the wrong results	4
	Performing calculations according to the right plan and less systematic but get the right results	3
	Performing calculations according to the right plan but less systematic and get the wrong results	2
	Not performing calculations according to the right plan	1
	Not performing calculations	0

Questionnaire responses were prepared based on student questionnaire responses presented in Table 3.

Table 3. Student's responses indicators.

Aspects	Criteria
Interest	Student's curiosity about learning material in exploration activities (Experiencing).
	The enthusiasm of students in linking the material with experience during group discussions and class discussions.
Belief	The courage of students in asking and expressing opinions in group discussions and class discussions (Cooperating).
	Student's feelings about the contextual problem in learning.
Ease of understanding the learning component	Completing SW is adjusted to REACT learning strategy and equipped with a graphic organizer.
	The Student's understanding of learning materials concept through the activities of connecting mathematical concepts with experience (Relating).
	Skills in applying mathematical concepts to solve contextual problems (Applying and Transferring) by using a graphic organizer.

The statements on the student response questionnaire consist of positive statements or negative statements and each statement contains five alternative answers according to the Table. 4.

### 3.4 Data Analysis Technique

The student's score that accordance with Table 2 was converted to values on a scale of 0-100 which were then grouped according to the category of classification values in Table 5.

Table 4. Scoring criteria for student's responses questionnaire.

Answer	Score of positive question	Score of negative question
Strongly Agree (SS)	5	1
Agree (S)	4	2
Less Agree (KS)	3	3
Disagree (TS)	2	4
Strongly Disagree (STS)	1	5

Table 5. Criteria for score classification of mathematical problem-solving test.

Score Range	Criteria
$\bar{X} \geq 80$	Very High
$60 \leq \bar{X} \leq 80$	High
$40 \leq \bar{X} \leq 60$	Fair
$20 \leq \bar{X} \leq 40$	Low
$\bar{X} < 20$	Very Low

The results of the student's responses questionnaire in accordance with Table 4 were grouped according to the category of score classification in Table 6.

Table 6. Criteria for student's responses classification.

Score Range	Category
$\bar{X} \geq 63$	Very Positive
$60 \leq \bar{X} \leq 63$	Positive
$39 \leq \bar{X} \leq 51$	Fairly Positive
$27 \leq \bar{X} \leq 39$	Negative
$\bar{X} < 27$	Very Negative

This research can be declared as successful if the percentage of the number of students who had scored with the high category reached 75% in the last cycle, and the average score of student's math problem-solving skills increase from one cycle to the next cycle, and student's responses of the implementation of REACT learning strategy with graphic organizer in terms of the average

score of minimal student responses in the positive category.

**4. RESULTS AND DISCUSSION**

**4.1 Result**

The result of the student’s mathematical problem-solving test on the initial reflection, the cycle I, cycle II, and cycle III is described in graph form as in Table 1 below.

Table 7. Average Score of Mathematical Problem-Solving Test

Stage	Average Score	Description
Initial Reflection	29.1	-
Cycle I	42.8	Increase
Cycle II	61.6	Increase
Cycle III	69.5	Increase

In Table 7, it can be seen that the average score of the problem-solving test had increased from 29.1 in the initial test and continued to increase up to 69.5 in cycle III. A summary of data of student’s mathematics learning completeness on initial reflection, the cycle I, cycle II, and cycle III can be seen in Table 8.

Table 8. Data Summary of Student’s Learning Completeness

Stage	Learning Completeness	Category
Initial Reflection	5.26%	Not yet reached
Cycle I	10.53%	Not yet reached
Cycle II	59.89%	Not yet reached
Cycle III	81.58%	Reached

In Table 8, it can be seen that student’s learning completeness in cycle III had reached 81.58 and it was more than 75%. The average score of student’s responses questionnaire to the implementation of REACT learning strategy with graphic organizer was 58.47. When compared to the criteria for classifying student’s responses in table 3, the responses provided by the students were in a positive category.

**4.2 Discussion**

Achievement of success indicators that can be seen through the improvement of mathematical problem-solving skills

and student’s learning completeness that had exceeded 75% which was the result of applied stages in REACT learning strategy and using a graphic organizer. Although the indicators of success in this study were achieved, the researchers still found the constraints during the learning process. Apart from the existing constraints, learning activities that were adjusted to the REACT learning strategy like at the stage of relating, experiencing, applying, cooperating, and transferring, in general, were very influential in improving student’s mathematical problem-solving skills. In addition, graphic organizer also greatly assisted students in solving problems in accordance with the steps of systematic problem-solving.

Learning began by introducing students with examples of real-life problems which related to learning materials (relating). Activities that can be performed are directing students to observe the roof of the canteen and ask students to guess how to determine the number of tiles on the roof of the canteen. Because the canteen roof is shaped like a pyramid, the teacher then emphasized back to the students that the number of tiles on the canteen roof can be searched with the concept of surface area of the pyramid. It aimed to enable students to connect their knowledge or experience with the mathematical concepts they learned so that the problem was chosen to be as close as possible to the student’s environment. Students were also asked to provide other examples that can utilize the concept of the pyramid. Learning was then followed by group discussion and class discussion (cooperating). In group discussion activities, students worked together in solving the existing problems in the Student Worksheet (SW). The ability of each student in understanding the problems and using mathematical concepts in solving the problems varied in each individual, so through group discussion activities, students can exchange their ideas with other members of the group.

At the time of the group discussion, sometimes students did not understand the purpose of the problem or the guidance provided by the SW so that the teacher should be able to act as a facilitator by providing intensive and structured learning support during group discussions. In accordance with the concept of the zone of proximal development (ZPD) that proposed by Vygotsky (in Upton, 2012), in the learning process, the student’s abilities are immature, but still in the process of maturation. Before the students solve the problems independently, the students need to be assisted in the learning process, so the teacher as facilitator needs to provide various types of assistance that can facilitate the students so that they can solve the problems they face. Such assistance may be the cognitive scaffolding such as giving examples of similar problems, instructions or guidelines, as well as steps or procedures for performing the tasks [18].

In group discussion activities, students undertook exploration activities (experiencing) through a hands-on activity in the form of object manipulation activities and problem-solving activities as an effort to construct their understanding of mathematical concepts. At each meeting, the student used a certain space made up of cartons to investigate the mathematical concepts of the figure. Students then practiced their ability to apply (applying)

mathematical concepts that had been constructed into the problems given to SW. The problem used was made as close as possible to the daily life of the students, in this case, the teacher can act as a motivator by making the problem-solving activity more realistic and relevant to the student's life. At one meeting, students were asked to determine the minimum area of plastic that used to coat the miniature of a pyramid. Thus, through applying activities, student's beliefs arise on the importance of learning from the concept and its relationship to the real world. Figure 1 below is the result of the student's graphic organizer at the experiencing stage.

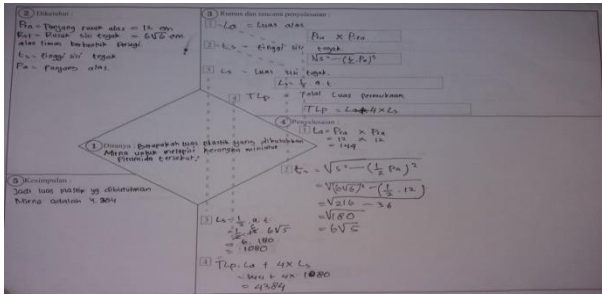


Figure 1. The result of Graphic Organizer at the experiencing stage.

Graphic organizer in Figure 1 is different from the graphic organizer in Figure 3. In Figure 1, the "Formula and completion plan" area, and the "completion" area there is a connecting line between the completion plan and the corresponding number. Connected lines aimed to make students accustomed to problem-solving in accordance with the completion plan that had been prepared. This is based on the concept of scaffolding, the student is given assistance in the form of samples or step-by-step directives that aim to simplify a task so that it can be completed and encourage and motivate students to be involved in solving it [18]. However, for the graphic organizer at the transferring stage, the assistance provided becomes more indirect and involves such things as asking questions to guide students to find their own solutions [18], so that the connecting lines and numbering that exist in the graphic organizer for phase transferring were abolished and it can be seen in Figure 3.

Students then applied the concept of mathematics into new contexts or new problems with more complex situations (transferring). Previously, the student had been asked to determine the minimum area of the plastic surface, but in this stage, the student was required to determine the cost of the material that used to coat the pyramidal roof. However, the abilities of the students vary from individual to individual, so in constructing the mathematical concept and applying the concept to a new or more complex situation it takes longer for all students to be able to solve the problem. explained that the individual personality of the student, especially in the readiness of the students in following the learning in the classroom is influenced by several aspects, one of them is intelligence of each student such as ability to think abstract, ability to understand inter-

conceptual relationships, and the ability to adapt to new situations that are of course different from each individual, so that students who had understood the material and the problems that were given on SW were assigned to guide their group members who had not understood [19]. Vice versa for group members who did not understand the material and problems that were given on SW were expected to actively ask their group members who already understand.

Teamwork is very important, in this case, Borko & Mayfield's [20] also stated that students who work individually usually do not give progress as well as students who work together in a group. Working together in a group can assist students in solving complex problems through effective communication and sharing of information [20].

In solving the problem during the learning process, students used a graphic organizer. Before they use of graphic organizer, many students had not been able to solve the problem in accordance with complete and systematic problem-solving indicators. Here is one of the results of student's problem solving before implementing REACT learning strategy and graphic organizer.

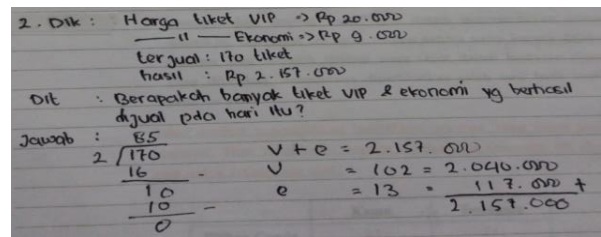


Figure 2. The result of Initial Test on VIII-14 class SMPN 2 Singaraja academic year 2017/2018

In Figure 2, it appears that students were less able to develop a plan that fits the right mathematical concepts. In contrast to the use of graphic organizer as an answer sheet for the problems that exist in SW, students were able to solve problems in accordance with the correct steps and systematic problem-solving. Figure 3 below is the result of student's problem-solving by using graphic organizer as an answer sheet for the problems that exist in SW.

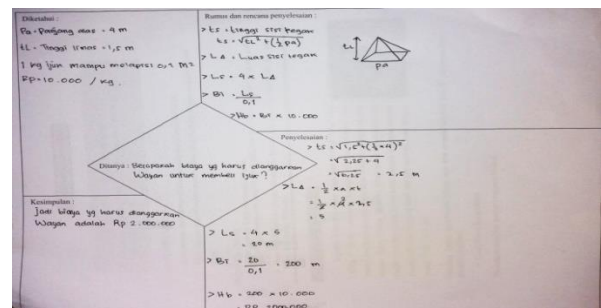


Figure 3. The result of Student's Graphic Organizer in cycle III

In Figure 3 we can see that the problem-solving plan developed by the students is very systematic and already contains mathematical concepts and relationships between mathematical concepts correctly. The student also completed the plan that composed of the meanings of the symbols used. There were also students who complete the plan with illustrations that match the existing problems, as well as in the problem-solving step, the calculations performed by the students were in accordance with the plans that they had been made.

In accordance with the results of student's responses questionnaire to the implementation of REACT learning strategy with graphic organizer, especially student's responses to the exploration activities (experiencing), like finding and understanding the concept of mathematics, there were students who were less interested in the concept of invention activities, and the average student answer "Doubtful" to the statement that the problems that existed in the SW make it difficult for students to understand the learning materials. In accordance with the results of observations that were performed during the research activities took place, this happened because not all students had the same ability to find and understand the concept of mathematics and apply the concept of mathematics in a complex or new context. In general, each individual is distinct from one another [19]. One aspect of the individual's personality that needs to be understood is the interest, like the student's interest in an object. This interest can be a motivation to students in learning, but interest is very much influenced by environmental factors when it is compared with factors from within student so that teachers should be able to recognize and generate interest from students in positive learning and able to achieve the achievement as good as possible. However, in general, the average questionnaire score of student's responses to the application of REACT learning strategy was in a positive category.

## 5. CONCLUSION

Based on the explanations that have been presented, regardless of the constraints that have been addressed, it can be concluded that the implementation of REACT learning strategy with graphic organizer had led the students to be able to improve the ability of mathematical problem-solving and got positive responses from students.

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