Improving Mathematical Problem-Solving Ability Through Means-Ends Analysis

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Abstract. The ability to solve mathematical problems becomes a crucial part of the mathematical learning process. That capacity can help learners solve the math problems they face in both the academic environment and daily life. However, the facts on the ground were turned around. Problem-solving is still very low. So the research aims to improve the ability to solve mathematical problems learners use Means-Ends Analysis (MEA) models in data distribution materials. This research is a kind of class action study. The research subject is the 7C student group of 29 students. Data collection techniques use observation, testing, and documentary techniques. Data analysis techniques using quantitative data. The results derived from this study are the implementation of the learning process using MEA learning models at Junior High School 1 Kabila 7C has to increase the problem-solving of learners. Based on the average educator observation from three observers, it shows 75% of cycles I to 93.3% of cycles II. And the observation of learners from 64.5% on cycle I to 81.2% on cycle II. And the average results test 69% ability on cycle I to 83% on cycle II.

1 Introduction

Education is a conscious effort to improve students' insight, skills, and character behavior. In addition, the process that takes place in the realm of education is a long process that must be based on the needs of students [1]. In supporting education to become more advanced, Indonesia made changes by implementing a new curriculum, namely Curriculum 2013.

This K13 has the goal of a learner-centered learning process, which means that students are asked to find problems independently and assisted by educators as facilitators in the classroom. With this, the knowledge they gain does not only focus on textbooks but covers all aspects of the material presented.

Mathematics plays an essential role in K13. Mathematics is closely related to other sciences such as science and technology, pharmacy, etc. Arsyad [2] and Bito [3] stated that the role of mathematics is what makes mathematics mandatory to be taught by an educator at every level of education. Moreover, according to Mawaddah and Hana [4], learning mathematics is not only understanding the concepts or procedures but many things can be derived from the outcomes of the mathematics learning process. The usefulness of mathematics learning is characterized by the awareness of what is done, what students understand, and what they do not understand about mathematical facts, concepts, relationships, and procedures.

In the 2013 Curriculum [5] mathematics has several learning objectives, including students could: 1) master the concept of learning mathematics; 2) generalize phenomena or data that are already available and use alternative ideas in solving problems; 3) reason and manipulate simple mathematics components in solving mathematical problems both in context and out of context; 4) convey ideas and be able to make mathematical proofs using mathematical symbols or other media in terms of emphasizing problems; 5) realize the importance of the role of mathematics in everyday life; 6) have characteristics related to mathematics; 7) carry out motor-related activities using mathematical knowledge; 8) using simple media or derived from technology development in mathematical activities.

In learning mathematics, one goal is most emphasized, namely problem-solving ability. Mathematical problem-solving can help students overcome the problems they encounter now or later. Like the anatomy of the human body, mathematical problem-solving is the heart and the primary standard of mathematics [6]. Furthermore, Wahyudi and Indri define problem-solving as a process of trying to find a way out of a difficult or unusual problem so that the problem does not become a problem [7]. In the process of learning mathematics, this ability becomes one of the essential things [8]. Because problem-solving is a cognitive strategy that is needed in all aspects of life, one of which is in learning activities [9]. Given the need for problem-solving skills, educators must analyze and determine to what extent these abilities are mastered by students, especially in data presentation material [10]. However, in PISA, students' mathematical problem-solving abilities are still deficient, especially in Indonesia, which is in the bottom ten and 73rd out of 79 countries in mathematics learning.

The PISA statement follows the facts in Junior High School 1 Kabila, especially in class 7C of Junior High

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School 1 Kabila. Students are still tricky in solving problems, especially in the form of stories. In addition, students are often wrong in interpreting and modeling problems into the mathematical form [11]. This is due to limited teaching time, which ultimately makes educators only pursue targets without doing anything so that participants can understand what is being conveyed.

In addition, students are still less responsive when responding to questions or problems related to solving mathematical problems posed by educators. Students also tend to feel afraid to explore themselves for fear of being wrong. This is also supported by previous observations in class 7C of Junior High School 1 Kabila, where students still have difficulty understanding mathematical concepts. In this case, it is difficult for the students to solve the tasks using the story problems. This can be seen in the following picture, which shows the results of the students' daily tests.

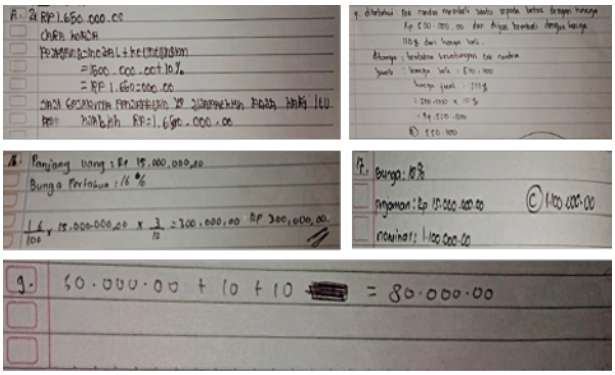

Figure 1. Student's daily tests

In the five pictures above, it can be seen that students' ability to solve a problem is still low. Learners tend to just write what is in the problem without knowing what they are writing. This is also due to students only following the work of their friends with the factor of being lazy to work or not understanding how to solve the problem-solving problems presented. In addition to not being able to recognize the problem, students also still do not understand solving the problems in the story problem. One of the materials in mathematics that requires the ability to solve problems is the presentation of data, especially in story problems.

From the observations that educators have made, there is one thing that is also a supporting factor for the low problem-solving ability, namely students have difficulty in converting story problems into mathematical models. In addition, educators find it difficult to improve students' problem-solving skills because the time provided during the Covid-19 pandemic has decreased, so they only try to pursue material targets so that they can finish. On the other hand, if educators try to understand and follow the will of students so that they can fully understand the material being taught, then other material can be left behind and may not even be taught, and learning is only through giving assignments without any detailed explanation from the educator.

This is also supported by an interview with Mrs. Karsum Badu, S. Pd., one of the educators in mathematics in class 7C of Junior High School 1 Kabila, who said that the low mathematical solution ability of students occurs because students do not master the material that has been explained. Students also do not understand what they write. He also said that the learning process that was carried out was still less than optimal due to the Covid-19 pandemic, thus requiring students to be able to adjust to this. He added that the learning models used by educators revolve around direct learning models with lecture and question-and-answer methods, as well as discovery learning models.

The inability of students to solve mathematical problems is certainly a serious problem that must be addressed properly. That is because if students cannot solve a mathematical problem, it can result in learning objectives not being achieved optimally. Therefore, based on the observations that have been made, the teaching and learning process in class 7C needs to be re-enhanced and improvements made to the teaching and learning process. In addition, the use of learning models also needs to be considered again because, so far, educators use direct learning models, and discovery learning is not optimal to apply. So there is a need for alternative learning models to be applied by educators.

One alternative learning model for improving mathematical problem-solving skills is using the MEA learning model. eMEA is a learning model designed to analyze a problem in various ways to achieve the desired end goal [12]. The MEA learning model has its advantages, namely that it can familiarize students with mathematical problem solving, be more active in expressing ideas and finding solutions, get many opportunities to utilize their knowledge and skills, be able to respond to problems faced according to their understanding, get hands-on learning experiences, and easily solve math problems. This is in line with Shoimin's statement that MEA can provide a great opportunity to be able to play an active role and achieve the ultimate learning objectives to achieved [13]. This Means-Ends Analysis learning model includes innovations from the problem-solving learning model.

2 Method

Classroom Action Research (CAR) is a form of reflective inquiry conducted by the education unit to increase rationality in all ongoing educational activities [14]. CAR is the method in this research. CAR is research that, in its application, aims to improve conditioning and the practice of learning mathematics to be more effective than before [15]. CAR is one of the studies conducted by researchers reflectively and collectively, aiming to increase the justification of social practices.

Mathematical problem-solving ability is the main focus of this study using the MEA learning model as a forum for conducting research in class 7C of Junior High School 1 Kabila. In comparison, this classroom action research design is in the form of a spiral (cycle) model by experts named Kemmis and McTaggart.

Table 1. Aspects of teacher activity

No.	Activities
	Identifying the Difference between Current State and Global State
1.	Provide motivation and convey learning objectives.
2.	Pose a problem at the beginning of learning and guide learners to come up with their ideas and theories.
	Organization Sub-Goals
3.	Encourage/ask learners to solve problems.
4.	Guide/encourage students to gather appropriate information in solving problems.
5.	Help train the ability to identify, formulate and solve students' problems.
6.	Encourage learners to collaborate/discuss in solving problems.
7.	Observe and guide learners to solve problem-solving problems in groups.
	Operator or Solution Selection
8.	Assist learners in reviewing the process/results of problem-solving.
9.	Guide students to solve and conclude the problem.
10.	Guide students who are not yet complete in solving the problem.

Table 2. Student activity criteria

No.	Observation Criteria
1.	Listen to the learning objectives and motivation conveyed by the educator.
2.	Listen/ pay attention to the educator's explanation.
3.	Read and examine textbooks, LKPD, to get involved in problem-solving activities.
4.	Define and organize learning tasks related to the problem at hand with assistance provided by the educator.
5.	Guide each other to identify problems, simplify problems, hypothesize, collect data, and prove and draw conclusions.
6.	Help each other to reflect on or evaluate their investigations and the processes they use.
7.	Summarize the learning outcomes.

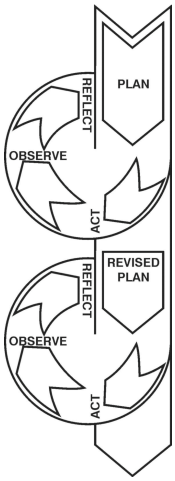

Figure 2. Kemmis and McTaggart spiral model (Source: [16])

This research is a collaborative study of mathematics teachers and students who are researchers. In addition to collaborating with subject teachers, this research also collaborates with an alumnus of the 2018 mathematics department who will be an observer. In this study, three observers will strengthen the research. Data collection techniques used are observation, test, and documentation techniques. This time, the observation technique was divided into two observations related to the activities of educators and students in the MEA learning process. The problem-solving test instrument was made by describing eight numbers in the first cycle and four numbers in the second cycle. This instrument has been empirically validated by three validators: two undergraduate lecturers - Mathematics and one mathematics teacher. It is intended that the test instrument is valid and reliable.

A variable in the study is considered a success when it meets the pre-determined criteria. In this study, there are three criteria, namely the criteria for teacher activities, the criteria for student activities, and the criteria for solving mathematical problems as listed on Tables 1 and 2.

In the assessment criteria, the score will be expressed in the value of mathematical problem-solving in the range 0 - 100. To obtain the average math problem-solving of students, the formula can be used:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \times 100\%, \quad (1)$$

where

$\bar{x}$: average mathematical problem-solving ability
$\sum_{i=1}^{n} x_i$: the sum of all test scores of students in class VII-C
n : number of students who took the test.

Result of the problem-solving ability of each learner $= \frac{x}{n} \times 100$, where

x : number of scores obtained,
n : total number of scores,

with the percentage of completeness

$$= \frac{\text{numbers of students who completed}}{\text{total numbers of students}} \times 100\%, \quad (2)$$

and the criteria for completeness is given by Table 3. In addition, the documentation technique used in this study is in the form of the results of a problem-solving ability test. Product moment correlation is a tool for the validity of the questions given to students.

Table 3. Criteria for student completion

Score	Criteria
≥ 75	Completed
< 75	Not Completed

3 Results and discussion

This classroom action research lasted for two cycles, with two sessions each in the first cycle and one Session in the second cycle, and one test in each cycle. This is because the first cycle has not experienced a significant increase.

This research was conducted in class 7C of Junior High School 1 Kabila, Bone Bolango Regency, for more than one month, starting from June 1, 2022, to July 5, 2022. Then, the subjects in this study amounted to 25 students with different abilities. The following is a description of the results and discussion of the research conducted during cycle I and cycle II.

3.1 Results of Observation of Educator Activities

Observation of educators in the learning process consists of 10 aspects. The following is a summary of the observations of educators' activities during cycles I and II.

Table 4. Summary of observation results of educator activities cycle I and II

Cycle	Session	Description
I	1	Educators can generally manage to learn using the MEA learning model with a total percentage of Good (B) and Excellent (SB) is 70%.
	2	In general, educators can manage to learn using the MEA learning model with a total overall percentage of Good (B) and Excellent (SB) is 80%.
II	3	In general, educators can manage learning using the MEA learning model with a total overall percentage of Good (B) and Excellent (SB) is 93.3%.

Based on the table above, the percentage obtained through the observations of educators' activities totaled with three observers in the first cycle is 75%. This is still far from the expected performance indicators. So it was continued in the second cycle, and the percentage increased to 93.3% from the initial results.

3.2 Results of Observation of Student Activities Observed

Students, seven criteria must observe. Figure 3 briefly describes the results obtained from observing student activities during cycles I and II. Based on Figure 3, the average percentage of the first cycle of the first meeting, which has been totaled with three observers, resulted in an average percentage of 58.6%, and the second meeting resulted in an average percentage of 70.5%. The average percentage of the first cycle became 64.5% with the quite active category. This is still less than the expected performance indicators. So that it continues until the second cycle, the average percentage obtained in the second cycle is 81.2%

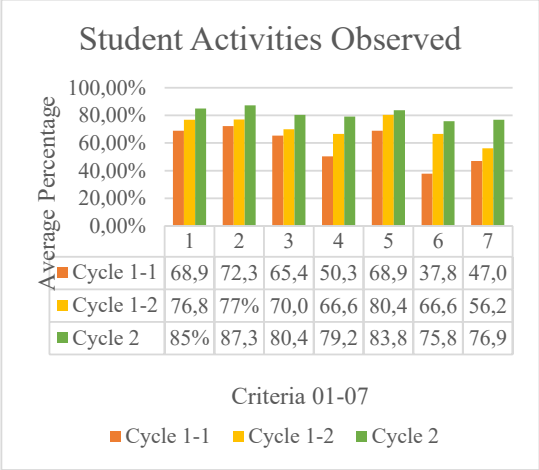

Figure 3. summary of student activity observation results

with the active category. So, the activities of students in following the learning process using the MEA model have increased by more than 1.2% of the pre-determined performance indicators.

3.3 Problem-Solving Ability Test Results

Assessment of the problem-solving ability test was given in the first cycle with as many as five questions and in the second cycle with as many as four questions with a success indicator of 75 and learning completeness of at least 80%. The following briefly describes the test results in cycles I and II.

Table 5. Summary of problem-solving ability test results

Cycle	Value	Number of students	Percentage	Completeness
I	≥ 75	20	69%	complete
	< 75	9	31%	incomplete
II	≥ 75	24	83%	complete
	< 75	5	17%	incomplete

Based on the table above, the percentage of completeness in Cycle I did not reach the minimum expected learning completeness. So that in the second cycle, the problem-solving ability test was again carried out, and the percentage of completeness in the second cycle reached successfully passing 3%, which was higher than the minimum specified learning mastery. In addition, this study has differences from several other studies, including research with the title "Improving Mathematical Problem Solving Ability on Circle Material using a Problem-Based Learning Model for Class VIII SMP Negeri 2 Tlogomulyo in the 2020/2021 School Year," which was researched by Nurul Azizah Desi Wulandari. This research with research conducted by researchers both focus on mathematical problem solving but with different learning models studied. The research conducted by Nurul has several shortcomings, including not examining the activities of educators and not examining the activities of students. In the study, researchers only focused on the value of students. At the

same time, both of these things are very related to the value produced by students. Research on the activities of educators and students is very important because, through these two things, it can be seen whether educators run the learning model by the specified aspects and find out whether students follow the learning process by pre-determined criteria. The results of research conducted by Nurul Azizah Desi Wulandari showed that mathematical problem-solving ability increased in cycle II by 80.45% while in research conducted by researchers increased in cycle II by 83%. This shows that the MEA learning model compared to the problem-solving model is much more effective.

4 Conclusion

Based on the results of research that has been done, we can conclude that MEA brings significant changes and good things in improving students' mathematical problem-solving abilities related to data presentation questions in the form of stories. This can be seen through the increase in the activities of educators in managing the MEA model from the first cycle by 75% with good and excellent categories to 93.3% in the second cycle and getting good and excellent varieties. The activity of students also experienced a significant increase, namely from 64.5% with the moderately active category in the first cycle to 81.2% with the active category in the second cycle. The increase in the activities of educators and students had a good impact on the results of the problem-solving ability tests carried out, from 69% in the first cycle to 83% in the second cycle. After this research is carried out, educators can re-evaluate the learning model that has been applied to be replaced or alternated using the MEA learning model as an alternative varied learning model. In addition, further researchers should also examine the application of this learning model by relating it to the learning styles of students at school.

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