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Efforts to Improve Mathematical Problem Solving Ability through the Flipped Classroom Learning Model in High Schools

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Abstract

This study aims to improve students' mathematical problem solving abilities. This research was conducted using classroom action research. The action taken is in the form of applying the flipped classrom learning model that is imposed on trigonometry learning. The research was conducted in 3 cycles. This research involved 32 students of class XI, a researcher as a teacher, and 1 observer. Research data were collected using the following instruments: (1) written test; (2) observation sheets; (3) interview sheet, and; (4) documentation. The collected data were analyzed using the Miles & Huberman method. The results of data analysis showed an increase in learning outcomes and an increase in students' mathematical problem solving abilities. The increase in learning outcomes is shown by the results of the posttest, namely: (1) the average value of learning outcomes in the first cycle is 67.28; (2) cycle II obtained by 72.97, and; (3) cycle III of 75.41. While the increase in problem solving ability is shown through the observation results sheet, namely: (1) cycle I of 47%; (2) cycle II increased by 71.87%, and; (3) cycle III increased again by 84.37%. These results indicate that student learning outcomes have reached the specified criteria, namely achieving a score of 74, and meeting the criteria for the percentage of problem solving abilities, namely 80%. So it can be concluded that classroom action in the form of applying the flipped classroom model can improve learning outcomes and improve students' mathematical problem solving abilities, especially in trigonometry material.

Keywords: flipped classroom, mathematical problem solving ability, trigonometry.

1 INTRODUCTION

Mathematics is taught to students in Indonesia from elementary to secondary level, one of the goals is to equip students with problem solving skills (Ministry of National Education, 2010). Through the learning process students will practice solving mathematical problems which will be useful when they are carrying out the process of integrating mathematics into other fields or when implementing it into everyday life problems (Ruseffendi, 2006). This goal is also in line with the mathematics learning outcomes standard from the National Council of Teachers of Mathematics (NCTM) which states that students are able to solve everyday problems with the help of the mathematical concepts and procedures they have learned (Bossé et al., 2010). It was also stated that strengthening the attitude of perseverance and never giving up for students during the process of solving mathematical problems is part of the cultivation of positive national character that needs to be continuously developed (Almerico, 2014; Freeman-Green et al., 2015; Rokhman et al., 2014). So strengthening problem-solving abilities in students through learning mathematics is very important. Previous experts such as Dewey (1916) and Bruner (1961) have also argued about the importance of an educational process that is oriented towards the formation of problem-solving competencies.

Unfortunately, the ability to solve mathematical problems which is the target of learning mathematics in schools in Indonesia has not fully met expectations. The results of the analysis of problem solving abilities carried out by previous researchers showed that students' mathematical problem solving skills at several levels of senior high school were still in the low category (Akbar et al., 2018; Nugraha & Zanthy, 2019; Rachmawati et al., 2021). To find out students' mathematical problem-solving abilities in more detail, the researcher made observations at one of the senior high schools in Karawang, Indonesia. Based on the results of the observations, the researchers obtained data on the ability to solve mathematical problems in the school, which was still relatively low. This is shown by the results of the School Final Examination where only 20% of students succeed in achieving the Minimum Mastery Criteria. To reassure the students' mathematical problem-solving skills in the class, the researcher gave pretest questions. The pretest results are presented in Figure 1.

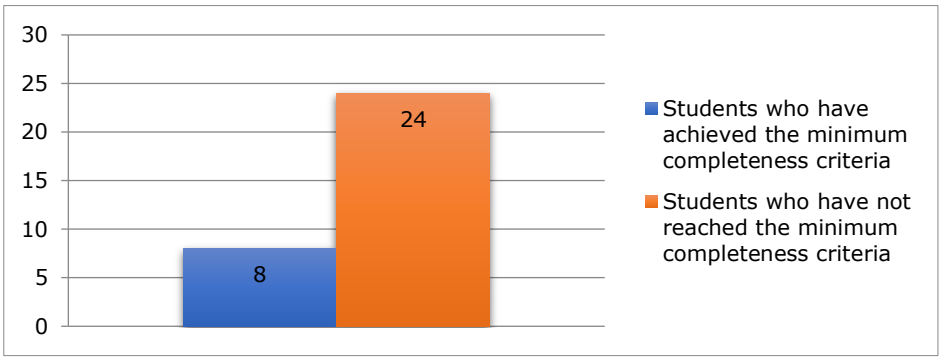


Figure 1. Pretest Results of Mathematical Problem Solving Ability

Through the pretest results shown in Figure 1, it can be seen that only 8 students or about 25% of the 32 students succeeded in achieving the minimum completeness criteria. So that through the results of this pre-test it can be said that the mathematical problem solving ability of students in that class is really low.

The next researcher made further observations to find out the factors causing the low ability to solve mathematical problems in that class. Based on observations made by researchers, it is known that the learning carried out during the pandemic did not yet integrate certain learning models that were oriented towards increasing mathematical problem solving abilities. This is of concern to researchers because if the teacher uses certain appropriate learning models it will have a positive effect on students' mastery of solving mathematical problems (Nurafifah et al., 2016). On the other hand, the researchers found that the students had not been motivated to be actively involved in problem solving from the contextual questions presented by the mathematics teacher in the class. The problems of learning mathematics encourage researchers to find alternative solutions. If it is based on these factors, the researcher is of the view that it is necessary to apply certain learning models that can encourage student activity in solving mathematical problem activities, and their application can be integrated with learning technology as recommended in the implementation of the Independent Curriculum. Through the application of certain learning models it is assumed that students' activeness in solving mathematical problems can increase and their learning achievements will also increase.

As a first step the researcher conducted a literature review. Based on the results of the literature review, the flipped classroom learning model can be recommended as an alternative solution that needs to be considered. Flipped classroom is recommended because it is a learning model that can maximize student activity through interaction with each other, namely the teacher, students and their environment, which can encourage an increase in students' mathematical problem solving abilities (Rohmatulloh & Nindiasari, 2021; Threlkeld, 2017; Widyasari et al., 2021; Zainuddin & Attaran, 2016). In addition,

the flipped classroom model is the right strategy and in accordance with the development of 21st century learning technology (Widyasari et al., 2021). Filpped classroom is a learning model that uses multimedia devices and technology to help change the delivery time of learning material so that students receive the most support when they are working with assignments that require a lot of additional theory when in class (Stelee, 2013).

Based on the explanation above, the researcher believes that the flipped classroom learning model needs to be implemented through a class action research as an effort to improve students' mathematical problem solving abilities, especially in classes that are the object of researcher observation. The application of the flipped classroom model will be applied to learning trigonometry material. The trigonometry material was chosen because it corresponds to the material in the academic calendar, and is based on the results of previous research which showed that high school students still experience difficulties when solving mathematical problems in the trigonometry material (Setiana et al., 2021; Tunnajach & Gunawan, 2021).

2 RESEARCH METHODS

This research is in the form of Classroom Action Research, namely research conducted on learning activities which are deliberately raised and actions carried out together in a class (Arikunto, 2021). The purpose of doing class action in this study was to improve the learning process with the ultimate goal of improving the mathematical problem solving abilities of class XI students. The class action carried out was in the form of applying the flipped classroom learning model to trigonometry material which consisted of 3 (three cycles). Each class action cycle is carried out following the procedure developed by Arikunto (2021) as shown in Figure 2.

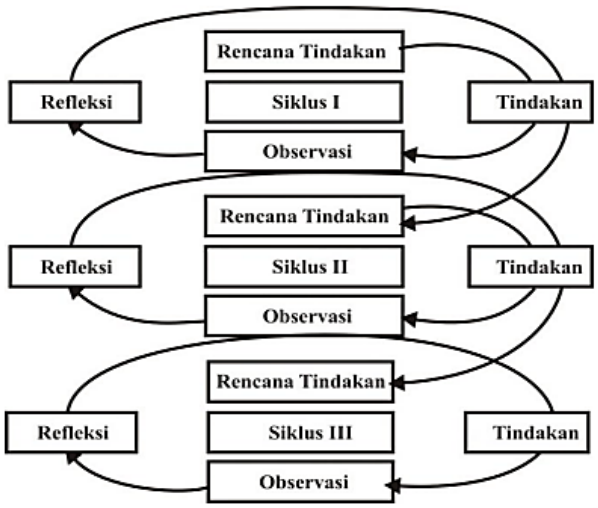


Figure 2. Classroom Research Model by Arikunto (2021)

It can be seen from Figure 2 that the classroom action research procedure carried out consists of the following stages: (1) planning; (2) action; (3) observation, and; (4) reflection. Before the class action was carried out, the researcher first carried out the pre-action stage which aimed to divide the learning material into the three planned cycles, as well as establish the initial conditions as the basis for measuring an increase in mathematical problem-solving abilities.

This classroom action research involved 32 students who were in one class and the researcher himself acted as a teacher. The other party involved is the senior

mathematics teacher at the school who acts as an observer. Research data were collected using written test instruments, observation, interviews, and documentation. The developed written test instrument contains indicators of problem-solving abilities from Polya (1985), which consist of: (1) understanding the problem; (2) determine a strategic plan for problem solving; (3) complete the strategic plan, and; (4) recheck answers. Observations were made using an observation sheet which contained indicators: (1) students focused on problems; (2) students are able to describe the sketch of the problem; (3) students carry out planning for completion; (4) students carry out plans, and; (5) evaluation of results. The interviews were conducted using the indicators contained in the interview guidelines. The data obtained was then processed using the method (Miles & Huberman, 1984) until a conclusion was drawn.

3 RESULT AND DISCUSSION

Before the action is taken, the researcher carries out the pre-action stage which consists of determining the initial conditions and dividing the material to be taught in each cycle. Determination of the initial conditions was carried out by providing pretest questions where the results were presented in Figure 1. Thus the initial conditions before the action was carried out showed that only 8 students (25%) passed. After going through 3 cycles of action, it is assumed that students who succeed in achieving scores will increase, and will be followed by an increase in students' mathematical problem solving abilities, especially in trigonometry material.

Through this pre-action stage, the researcher then divided the trigonometry material into 3 cycles, namely cycle 1 and cycle 2 with the subject of trigonometry equations, and cycle 3 with the subject of the number and difference of angles. Furthermore, class action is carried out whose results are as explained below.

3.1 Class Action Results in Cycle 1

Cycle 1 was held for 3 meetings with 2 hours of lessons each meeting. The first meeting on 4 May 2023 discussed the learning process and material for trigonometry, the second meeting on 5 May 2023 discussed material for trigonometry, and the 3rd meeting on 11 May 2023 held a posttest. The following is an explanation of the results of the action based on the research stages in cycle 1.

3.1.1 Results of the Planning Stage

The results of the planning stages are: (1) Learning Implementation Plans with material limitations on trigonometry equations; (2) develop the posttest instrument cycle 1 which consists of 5 questions; (3) compiling observation sheets; (4) compiling interview sheets, (5) dividing student groups according to the needs of the application of the flipped class room model, and; (6) prepare learning videos on the subject of trigonometry equations.

3.1.2 Results of Implementation Phase

At the implementation stage of the first meeting the researcher started the learning activity by informing the results of the division of study groups which were divided into 6 groups consisting of 5 to 6 students. Furthermore, the researcher provided a learning video link to be studied at home and used as material for group discussion at the next meeting. At the second meeting the second meeting carried out learning activities with group discussions with the subject matter contained in the learning video. Meetings 1 and 2 in cycle 1 generally ran smoothly and were attended by observers who observed the activities of researchers who acted as teachers and observed student activities in the class. Then at the 3rd meeting a posttest question will be given.

At the 3rd meeting a posttest was carried out which was attended by 32 students. The posttest went smoothly, the results of which are presented in Table 1.

Table 1. Posttest Cycle 1 Results

Achievement	The number of students	%	Average
Pass Criteria	15	47%	67,25
Did'n Pass Criteria	17	53%	

Table 1 shows that 47% of students achieved the Minimum Pass Criteria score and 53% of students had not yet completed. While the success criteria set are 80% of students pass. This shows that student achievement in cycle 1 is still low and needs to be improved in the next action process.

3.1.3 Observation Phase Results

Based on the results of observations of students, it is known that each student shows different behavior when receiving learning. Based on the observation sheet, it can be shown that the percentage of students' problem-solving abilities in cycle 1 was 61.17%, while the success criteria set were 75%. Based on observations, it was also found that students were less focused, which was shown by disruptive behavior of other students, and students were also found to feel anxious when they did not understand the problem-solving steps that should be taken. The observer's observations show that researchers as teachers need to increase learning activities in the hope of making students more focused on the problem-solving process they are facing.

3.1.4 Results of the Reflection Stage

Based on the results of observations, there are several things that need to be corrected in the action cycle 2, including the researcher needs to increase activity with the aim of making students more focused on the learning process. In addition, researchers as teachers will take a personal approach to motivate students who still have mathematical anxiety. Through this improvement it is hoped that student learning outcomes in cycle 2 will increase.

3.2 Class Action Results in Cycle 1

Cycle 2 was held for 3 meetings with 2 hours of lessons each meeting. The first meeting on 12 May 2023 discussed the learning process and material for trigonometry, the second meeting on 17 May 2023 discussed material for trigonometry, and the 3rd meeting on 19 May 2023 held a posttest. The following is an explanation of the results of the action based on the research stages in cycle 2.

3.2.1 Results of the Planning Stage

The results of the planning stages are: (1) Learning Implementation Plan with material limitations still on trigonometry equations; (2) develop the posttest instrument cycle 1 which consists of 5 questions; (3) compiling observation sheets; (4) compiling interview sheets, (5) dividing student groups according to the needs of the application of the flipped class room model, and; (6) prepare learning videos on the subject of trigonometry equations.

3.2.2 Results of Implementation Phase

At the implementation stage of the first meeting the researcher started the learning activity by informing the results of the division of study groups which were divided into 6 groups consisting of 5 to 6 students. Furthermore, the researcher provided different learning video links from cycle 1 to be studied again at home and used as material for group discussion at the next meeting. At the second meeting the second meeting carried out learning activities with group discussions with the subject matter contained in the learning video. Meetings 1 and 2 in cycle 2 generally ran smoothly and were attended by observers who observed the activities of researchers who acted as teachers and observed student activities in the class. Then at the 3rd meeting a posttest question will be given.

At the 3rd meeting a posttest was carried out which was attended by 32 students. The posttest went smoothly, the results of which are presented in Table 2.

Table 2. Cycle 2 Posttest Results

Achievement	The number of students	%	Average
Pass Criteria	23	71,87%	72,97
Did'n Pass Criteria	9	28,13%	

Table 2 shows that 71.87% of students achieved the Minimum Pass Criteria scores and 28.13% of students had not yet completed. While the success criterion that is maintained is 80% of students complete VALUE. This shows that student achievement in cycle 2 still does not meet the success criteria that researchers expect and needs to be improved in the next action process.

3.2.3 Results of the Observation Phase

Based on the results of observations of students, it is known that each student shows different behavior when receiving learning. Based on the observation sheet, it can be shown that the percentage of students' problem-solving abilities in cycle 2 was 74.17%, while the success criteria set were 75%. Based on observations in cycle 2, there were many students who showed an increase in problem-solving abilities, but there were still students who were lacking in terms of describing physical problems, planning solutions to evaluating results which resulted in them getting the lowest score in class because they were less active during discussion activities in class. The results of observer observations show that researchers as teachers need to increase learning activities in the hope of making students more active in the learning process of discussions in class.

3.2.4 Results of the Reflection Stage

Based on the results of observations, there are several things that need to be corrected in the action cycle 3, including the researcher needs to increase learning activities again in the hope that students can be more active in the learning process in class discussions. Through this improvement it is hoped that student learning outcomes in cycle 3 will increase.

3.3 Class Action Results in Cycle 1

Cycle 3 was held for 3 meetings with 2 hours of lessons each meeting. The first meeting on May 25 2023 discussed the learning process and material on trigonometry amounts and differences, the second meeting on May 26 2023 discussed material on trigonometry equations, and the 3rd meeting on May 31 2023 held a posttest. The following is an explanation of the results of the action based on the research stages in cycle 3.

3.3.1 Results of the Planning Stage

The results of the planning stages are: (1) Learning Implementation Plan (RPP) with material limitations still on trigonometry amounts and differences; (2) develop the posttest instrument cycle 1 which consists of 5 questions; (3) compiling observation sheets; (4) compiling interview sheets, (5) dividing student groups according to the needs of the application of the flipped class room model, and; (6) prepare learning videos on the subject of trigonometry equations.

3.3.2 Results of Implementation Phase

At the implementation stage of the first meeting the researcher started the learning activity by informing the results of the division of study groups which were divided into 6 groups consisting of 5 to 6 students. Furthermore, the researcher again provided a learning video link with trigonometry sums and differences to be studied again at home and used as material for group discussion at the next meeting. At the second meeting

the second meeting carried out learning activities with group discussions with the subject matter contained in the learning video. Meetings 1 and 2 in cycle 2 generally ran smoothly and were attended by observers who observed the activities of researchers who acted as teachers and observed student activities in the class. Then at the 3rd meeting a posttest question will be given.

At the 3rd meeting a posttest was carried out which was attended by 32 students. The posttest went smoothly, the results of which are presented in Table 3.

Table 3. Cycle 3 Posttest Results

Achievement	The number of students	%	Average
Pass Criteria	27	84,37%	75,41
Did'n Pass Criteria	5	15,63%	

Table 3 shows that 84.37% of students achieved the Minimum Pass Criteria scores and 15.63% of students had not yet completed. While the success criteria set are 80% of students completing VALUE. This shows that the achievement of student learning outcomes in cycle 3 has met the expectations of researchers with a total percentage of more than 80%.

3.3.3 Observation Phase Results

Based on the results of observations of students, it is known that each student shows different behavior when receiving learning. Based on the observation sheet, it can be shown that the percentage of students' problem-solving abilities in cycle 3 was 81.83%, while the success criteria set were 75%. Based on these percentages, it can be concluded that the Flipped Classroom learning model has succeeded in achieving more than 75% of the researchers' expectations.

3.3.4 Results of the Reflection Stage

Based on the results of observations in cycle 3, both student learning outcomes and the level of student problem solving have increased, and both have achieved the success criteria expected by the researcher. Therefore this class action research was not continued in the next cycle, and the research was considered successful.

3.4 Discussion

The results of giving action in the form of applying the flipped classrom learning model in cycle 1 were shown by the results of the post test, namely students achieving a score of 47% and the results of observing students' mathematical problem solving abilities of 61.17%. Furthermore, the researchers made improvements to the learning process in cycle 2 according to the suggestions made by the observer. The results of giving action in cycle 2 showed an increase in learning outcomes, namely students who achieved a score of 71.87% and a percentage of problem solving abilities of 74.17%. In cycle 3 the researcher used 3 meetings accompanied by improvements to the learning process according to the observer's suggestions. The results of the actions in cycle 3 showed an increase in learning outcomes, namely students who achieved a score of 84.37% and a percentage of problem solving abilities of 81.83%. In general, the increase in student learning outcomes from cycle 1 to cycle 3 is presented in Figure 3.

Based on Figure 3 researchers have been able to show an improvement in learning outcomes in each cycle. In cycle 3, there were 27 students or around 84.37% who had reached the minimum requirements criteria, which indicated that the learning process had reached the specified completeness criteria, which was 80%. If the increase in achievement of the minimum completeness criteria is calculated, then from the pre-cycle stage to cycle 1 there is an increase of 22%, from cycle 1 to cycle 2 it increases by 24.80%, and from cycle 2 to cycle 3 it increases again by 12.57%. The increase in the percentage of students' problem solving abilities is presented in Figure 4.

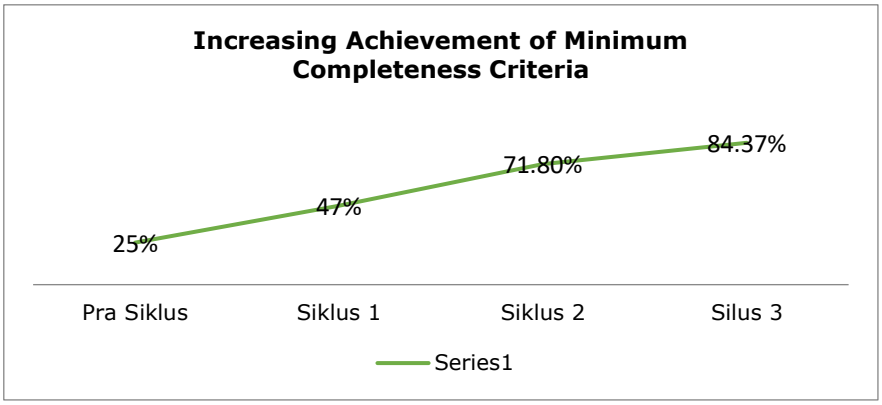


Figure 3. Improved Learning Outcomes in Each Cycle

Based on Figure 4 researchers have been able to show an increase in problem solving abilities in each cycle. In cycle 3 it appears that 81.83% of the problem-solving ability of all students has shown that the learning process has reached the set criteria of completeness, which is 75%. If you calculate the increase in mathematical problem solving ability, from cycle 1 to cycle 2 it increases by 13%, and from cycle 2 to cycle 3 it increases again by 7.66%.

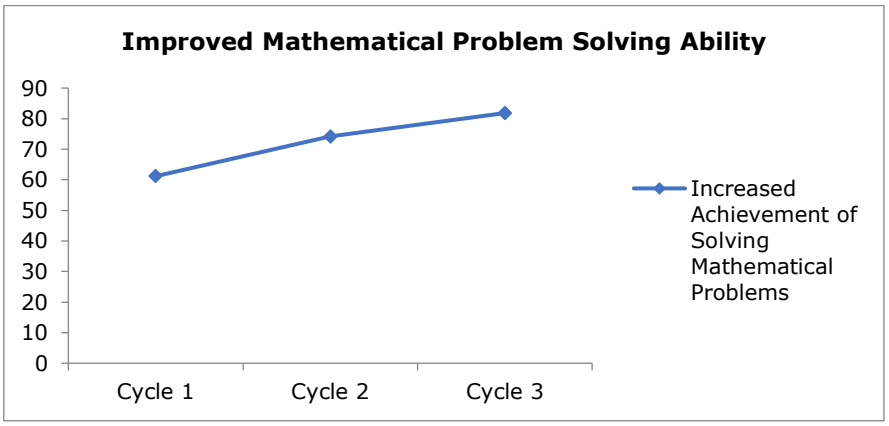


Figure 4. Percentage Increase in Students' Mathematical Problem Solving Ability

Based on Figure 4, the researcher has been able to show that providing classroom action through the application of the flipped classrom model has proven to be able to improve learning outcomes and also improve mathematical problem solving abilities, especially in teaching trigonometry material for class XI. The results of this study are in line with the results of previous studies, including research conducted by (Widyasari et al., 2021) which stated that there was an increase in mathematical critical thinking skills and learning motivation in Madrasah Tsanawiyah students in learning using a flipped classroom. Meanwhile, research (Saputra & Mujib, 2018) states that students' understanding of mathematical concepts using the flipped classroom learning model is better than the ability to understand concepts using the lecture learning method.

4 CONCLUSION

Based on the results of data analysis researchers have been able to show an increase in student learning outcomes and an increase in problem solving abilities. The increase in learning outcomes is shown by the results of the posttest, namely: (1) the average value of learning outcomes in cycle I is 67.28; (2) in cycle II it was obtained at 72.97, and; (3) in the third cycle of 75.41. While the increase in problem solving ability is shown through

the observation results sheet, namely: (1) problem solving ability in the first cycle of 47%; (2) in cycle II increased by 71.87%, and; (3) in cycle III it increased again by 84.37%. These results indicate that student learning outcomes have reached the specified criteria, namely achieving a score of 74, and meeting the criteria for the percentage of problem solving ability, which is equal to 80%. So it can be concluded that classroom action in the form of applying the flipped classroom model can improve learning outcomes and improve students' mathematical problem solving abilities, especially in trigonometry material. Thus the research conducted has achieved the stated research objectives.

5 ACKNOWLEDGEMENT

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