IMPROVING MATHEMATICS LEARNING OUTCOMES OF PYTHAGOREAN THEOREM THROUGH JIGSAW TYPE COOPERATIVE METHOD

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A R T I C L E   I N F O

Abstract. This research aimed to determine the extent to which the learning outcomes of class VIII G students of SMP Negeri 14 Denpasar had improved through the Jigsaw Type Cooperative learning method in learning mathematics regarding the Pythagorean Theorem. This research was classroom action research with the research subject being class VIII G of SMP Negeri 14 Denpasar Semester 1 in the academic year 2023/2024. Data on student learning outcomes was collected using written tests in the form of multiple choices. The result of this research showed that the first increase occurred in cycle I, 22 of the 42 students who took the test completed the test with a percentage of 52.4%. In cycle II, there was an increase in students who completed the test by 34 students out of 42 students who took the test with a percentage of 81%. It could be concluded that there was an increase in student learning outcomes in learning mathematics regarding the Pythagorean Theorem by applying the Jigsaw Type Cooperative learning method.

INTRODUCTION

The progress of a country cannot be separated from the role of education. Education is one of the supporting factors for producing the nation's next generation of quality in the future to advance the country. In the process of human development, education plays an important role in the process of transferring knowledge which will be able to improve the quality of human resources (Widana et al., 2022). Teaching and learning activities in the classroom require two-way educational interaction between teachers and students (Sukendra et al., 2023). A child's future interactions are influenced by the education provided. In learning activities, activity is really needed, this is because if there is no activity, the learning process cannot possibly run well (Nirta, 2019).

In managing the learning process, teachers need skills to convey lesson material (Sumandya et al., 2023). In order to successfully achieve the goal, the delivery of material by the teacher needs to pay attention to the most important issue besides the subject matter, namely the use of learning models. The learning model is used to simplify the learning process in achieving

learning goals (Purnadewi & Widana, 2023). A learning model is an arrangement of plans used as a guide in planning learning activities to help students achieve learning goals and is expected to improve student learning outcomes. In general, the learning model describes the learning environment including strategies, methods and learning materials in the form of learning tools or teaching materials or learning content that systematically influence each other in achieving learning goals (Amsikan et al., 2023). This learning can be carried out through cooperative learning. Cooperative learning is learning that prioritises cooperation between students in groups to achieve learning goals (Sallim, 2023).

One learning model that can be used to improve student learning outcomes is the jigsaw type cooperative learning model. Jigsaw type cooperative learning is a type of cooperative learning that encourages students to be active and help each other in mastering subject matter to achieve maximum achievement (Susmariani et al., 2022). The jigsaw type cooperative learning model is a learning technique in which students have greater responsibility in implementing learning, not the teacher (Djabba, 2020). The advantage of the jigsaw type cooperative learning model is that it is an efficient way of learning material because it is divided into several groups and each group studies one of the topics given by the teacher (Anitra, 2020). Research on the jigsaw type learning model has been conducted by several researchers. Resmi (2022) states that the application of the jigsaw type cooperative learning model to the fourthgrade elementary school students can improve mathematics learning outcomes. Lapase (2020) points out positive results, where there is an increase in student learning activities and students feel interested and happy in learning. Purwaningsih & Harjono (2023) conclude that the jigsaw type cooperative learning model can improve critical thinking and mathematics learning outcomes for the elementary school students.

One of the important materials in learning mathematics is the Pythagorean Theorem (Hasan, 2021). The Pythagorean Theorem is a formula found in mathematics in the geometry section. This formula is useful for showing the relationship between the lengths of the sides of a right triangle and one of the 90^0 angles. The Pythagorean formula was first discovered by a Greek philosopher and mathematician, namely Pythagoras. Pythagoras was born in 570 BC on Samos Island, Lonia area. Pythagoras studied mathematics. Pythagoras was known as a smart student. He is interested in studying many things such as astronomy, geometry and logistics. The Pythagorean Theorem is one of the fundamental concepts in studying geometry in mathematics.

Learning outcomes are abilities or changes in behavior obtained from the learning process (Widana & Laksitasari, 2023). Mathematics learning outcomes are the results achieved by students as evidence of success in using the teaching materials developed. This success is assessed from students' understanding of learning concepts and students' ability to solve problems related to the mathematics material being taught (Yupani & Widana, 2023). The result of learning is a change in overall behavior, not just one aspect of its potential. The change in oneself that is meant is a change for the better, but a change in a bad direction is not considered a result of learning. By studying, a person will gain as much knowledge as possible and can use it for something better and more useful. Learning outcomes are the abilities that students acquire and possess after they receive learning experiences in the learning process.

The factors that influence learning outcomes include:
a. Factors within students: (1) physical factors, which relate to physical health; (2) psychological factors, related to the way of thinking, attention, interests, talents, maturity

when thinking, and readiness to receive information; (3) fatigue factor, found in physical and spiritual fatigue.

b. Factors outside the student: (1) family factors, this plays a role in how parents are raised, relationships between family members, household conditions, family economic situation, and cultural principles applied at home; (2) school factors, which concern the teaching methods provided by the teacher, the curriculum, the relationship between students and students, the atmosphere or condition of the building, learning methods and homework assignments; (3) community factors, which relate to how students engage in social activities, social friends, and forms of community life.

The jigsaw learning model has a number of advantages, including: increasing student learning activities through discussion activities, involving students in discovering concepts, improving student communication skills through presentations and discussions, and improving student reasoning (Widana & Umam, 2023). The syntax of the jigsaw learning model can be described as follows.

Table 1. Jigsaw learning model syntax

Phase	Teacher and Student Activities
Phase 1 Communicate goals and motivate students	The teacher conveys all the learning objectives to be achieved in the lesson and motivates students to learn.
Phase 2 Presenting Information	Teachers present information to students by presenting various facts and experiences that are directly related to the subject matter.
Phase 3 Group or home/basic group	Students are grouped into home/basic groups with members of 5 to 6 people with heterogeneous academic abilities. Each group member is given a different sub-subject or topic for them to study.
Phase 4 Expert group	The teacher asks students who have the same topic to discuss in expert groups.
Phase 5 The expert team returns to the group	Siswa kembali ke kelompok asal/dasar untuk menjelaskan apa yang mereka dapatkan dalam kelompok ahli.
Phase 6 Evaluation	All students are given tests covering all topics.
Phase 7 Give rewards	Teachers give awards both individually and in groups.

For this reason, the researchers are tirggered to conduct research which aims to determine the extent to which the learning outcomes of class VIII G students of SMP Negeri 14 Denpasar had improved through the Jigsaw Type Cooperative learning method in learning mathematics regarding the Pythagorean Theorem.

METHOD

This classroom action research was carried out at SMP Negeri 14 Denpasar which is located at Jalan WR Supratman No. 18, Kesiman Kertalangu, East Denpasar District, Denpasar City, Bali. The design of each cycle consisted of four stages namely: a) planning, b) implementation, c) observation, d) reflection. In this study, the initial procedure is described as follows.
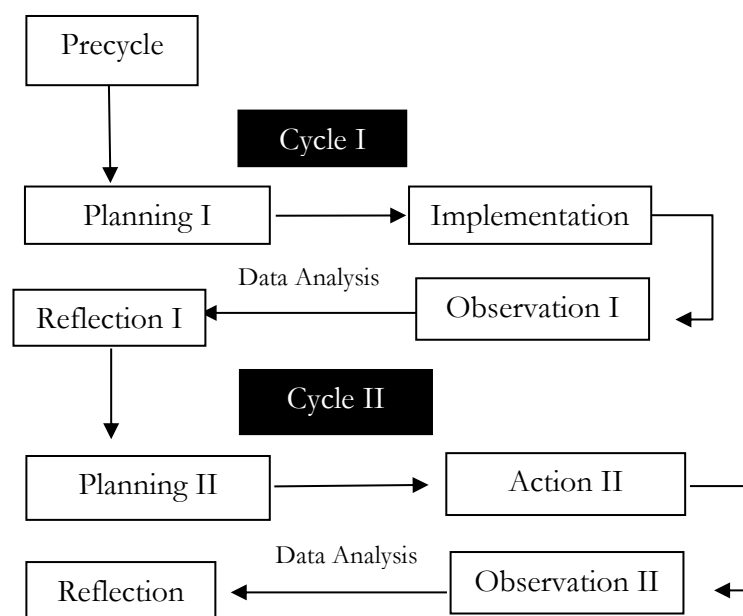
Image 1. Cycle Implementation

The research subjects were students in class VIII G of SMP Negeri 14 Denpasar in the first semester of the academic year 2023/2024 with a total of 42 students consisting of 23 female students and 19 male students. The object studied was related to the use of the jigsaw type cooperative learning model to improve student learning outcomes in class VIII G. Data on student learning outcomes were collected using tests adapted to the class material, the questions given to students were adapted to the cooperative learning model type. The process of collecting data on learning outcomes through observation is carried out by recording and interpreting existing information and collecting data through documentation in the form of taking photos as evidence of ongoing activities to improve student learning outcomes through the jigsaw type cooperative learning model.

Data on student mathematics learning outcomes were analysed based on the standard score. Students were declared to have achieved their learning objectives if the score obtained was more than 80. Then the percentage of student learning outcomes that achieved the KKTP was calculated using the following formula.

$$P = \frac{JSK}{JSS} x\ 100\%$$

Note:
P   = Percentage of students achieving the standard score
JSK = Number of students reaching the standard score
JSS = Total number of students

The implementation of the Jigsaw Type Cooperative Learning Model was said to be successful when (1) there was an increase in the average score of students' mathematics learning outcomes in each cycle and at least they were in the complete category, where the complete category meant students achieved a minimum score of 80. (2) The research was

said to be successful when the percentage of students who passed was more than or at least 75% of the total students.

RESULTS AND DISCUSSION

Before carrying out the research, class VIII G students were first given a diagnostic test (pre-cycle) which aimed to determine students' initial abilities related to the Pythagorean theorem material. The diagnostic test (pre-cycle) was developed independently by the research team, consisting of 10 questions, the form of the diagnostic test (pre-cycle) was multiple choice. The results of the diagnostic tests were as follows.

Table 2. Diagnostic Test Results (Pre-Cycle) Class VIII G
SMP Negeri 14 Denpasar

No.	Data	Score
1	Class average	59,52
2	14 students from 42 students completed	33,33%

When the results of the diagnostic test above were compared with the research success criteria, it showed an average score of 59.52, far below the KKTP score of 80. Likewise, classical completeness reaching 33.33% was still far below the success criteria, namely at least 75%.

In cycle I, several activities carried out by researchers were related to action planning, namely (1) analysing student learning styles, (2) analysing the flow of learning objectives and learning outcomes as well as formulating learning objectives (3) creating teaching modules and (4) creating study groups for students.

The implementation of the first cycle of research was carried out in 2 meetings. The time allocation for each meeting was 2 x 40 minutes. The actions taken in cycle I were adapted to the model applied by researchers, namely the Jigsaw Type Cooperative Learning Model. The first meeting in cycle I was held on Tuesday, 17 October 2023 at 08.50–10.20 and the second meeting was held on Thursday, 19 October 2023 at 07.30–08.50. Learning activities in cycle I were divided into three activities, namely (1) preliminary activities (2) core activities and (3) closing activities. These learning activities were carried out based on the Independent Curriculum Teaching Module that had been prepared.

After the end of cycle I, the teacher gave a final test, namely Post Test Cycle I with a multiple choice test consisting of 10 questions regarding the Pythagorean Theorem. The test results in cycle I were presented as follows.

Table 3. Learning Result Scores for Cycle I Class VIII G of
SMP Negeri 14 Denpasar

No.	Data	Score
1	Class average	75,23
2	22 of the 42 students passed	52,4%
3	20 of the 42 students did not pass	47,6%

Based on the table above, 22 students (52.4%) were categorised as "pass" and 20 students in the in "did not pass" category (47.6%). Based on the scores obtained from the tests given on the Pythagorean Theorem material, it could be concluded that the application of the Jigsaw

Type Cooperative Learning Model to increase the achievement of complete learning outcomes on the Pythagorean Theorem material for class VIII G students at SMP Negeri 14 Denpasar could not be said to be successful. This was because the average class score achieved in learning in cycle I was only 52.4%, while the target or desired score was 75% and above. This indicated that the implementation of cycle I needed to be continued and improved in the next cycle by knowing the obstacles found in cycle I.

The learning results in cycle I showed that the research had not yet reached the criteria for success, but the progress that had been achieved must be maintained and improved. However, in learning mathematics material on the Pythagorean Theorem, namely in learning by applying the Jigsaw Type Cooperative Learning Model, several obstacles were found. The obstacles found in the implementation of cycle one were students who were not concentrating in participating in learning activities. They did not focus on studying and there were some students who joked and chatted with their group friends. This of course disturbed the comfort of other students' learning, students who were concentrating on learning became distracted because of the jokes made by their friends.

Apart from that, another factor that caused the low grades obtained was that there were some students who did not actively participate in completing the assignments given, they just sat there waiting for the answers made by their group friends. The solution that could be done was that the teacher provided students' worksheets and gave assignments to all group members to write them in notebooks. This was done so that students did not joke or chat anymore and just focused on solving the problems given in the students' worksheets.

The activity planning carried out in cycle II was almost the same as cycle I. It was just that the learning planning in cycle II included several improvements such as (1) improving group divisions to make them more heterogeneous (2) maximising discussions by adding questions and the duration of time to work on them. The implementation of learning activities in cycle II continued with the next material, namely special triangles, application of the Pythagorean theorem and the distance formula.

The implementation of cycle II research was carried out in 2 meetings. The time allocation for each meeting was 2 x 40 minutes. The actions taken in cycle II were adapted to the model applied by researchers, namely the Jigsaw Type Cooperative Learning Model. The first meeting in cycle II was held on Tuesday, 24 October 2023 at 08.50–10.20 and the second meeting was held on Thursday, 26 October 2023 at 07.30–08.50. Learning activities in cycle II were divided into three activities, namely (1) preliminary activities (2) core activities and (3) closing activities. These learning activities were carried out based on the Independent Curriculum Teaching Module that had been prepared.

After the end of cycle II, the teacher gave a final test, namely Post Test Cycle II with a multiple choice test consisting of 10 questions regarding the Pythagorean Theorem. The test results in cycle II were presented as follows.

Table 4. Learning Result Scores for Cycle II VIII G of SMP Negeri 14 Denpasar

No.	Data	Score
1	Class average	85,47
2	34 of the 42 students passed	81%
3	8 of the 42 students did not pass	19%

Based on the table above, there were 34 students in the "pass" category (81%) and 8 students in the "Did not pass" category (19%). Based on the scores obtained in the table above, it could be concluded that the application of the Jigsaw Type Cooperative Learning Model to increase the achievement of complete learning outcomes in the Pythagorean Theorem material for class VIII G students at SMP Negeri 14 Denpasar had been said to be successful. This was because the average class score achieved in learning in cycle II was 81%. It was in accordance with the initial design in this research, namely that the action was declared successful if 75% of students achieved a minimum achievement score of 80.

Based on the results of research in cycle II, the value obtained in cycle II was greater than the value obtained in cycle I. Therefore, the best action in this research was the action in cycle II. In cycle II, the teacher carried out the actions as well as possible. In implementing the Jigsaw Type Cooperative Learning Model, it turned out that this action had an influence on student learning outcomes. The material presented by the teacher was explained clearly, in detail and provided examples of questions first before students carried out the assignments given. This made students understand more about the lesson material provided. The learning outcomes in cycle II performed by students increased. This indicated that students were very motivated to get better grades in learning Mathematics regarding the Pythagorean Theorem.

CONCLUSION
Based on the research results above, it can be concluded that the application of the Jigsaw Type Cooperative learning model can improve student learning outcomes. Recommendations that can be conveyed from this research are (1) teachers should be creative in implementing the Jigsaw type cooperative learning model by forming home groups and expert groups so that students can learn effectively and efficiently together with their group mates to understand the tasks given. (2) Increasing learning activities in each cycle are closely related to the presentation of material and practice questions, therefore teachers can increase students' interest in learning through good presentation of material and varied practice questions.

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