e-ISSN: 3025-7638

p-ISSN: 3025-1842

IJRME International Journal of Research in Mathematics Education

Vol. 1 No. 1, July 2023

UIN Prof. K.H. Saifuddin Zuhri Purwokerto

Fakultas Tarbiyah dan Ilmu Keguruan

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

Editorial Team

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

Tabel of Contents

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 1-12
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

The Integration of Ethnomathematics at Masjid Al Mahdi in Discovery Learning-Based Textbook on Students' Reasoning Ability

Adi Satrio Ardiansyah[1]✉, Yudhi Wahyu Adi[1], Fakhrur Rini Choirunnisa[1], Deva Fitria Wardani[1], Fatkhiya An-Nisa Raharani[1]

[1]*Universitas Negeri Semarang, Semarang, Indonesia*

✉ *Corresponding email:* adisatrio@mail.unnes.ac.id

Received February 25, 2023
Accepted May 24, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.7865

Abstract: Presenting meaningfulness in the process of learning mathematics is something that must be prioritized to achieve the goals of learning mathematics. However, the fact states that students' mathematical skills (especially mathematical reasoning) are still low. One alternative that can be done is through Ethnomathematics integration and the implementation of the Discovery Learning model. Developing Discovery Learning-Based Textbook with Ethnomathematics nuances at the Masjid Al Mahdi Magelang on students' reasoning abilities is the aim of this research. Research and development with a modified 4D into a 3D model consisting of Define, Design, and Develop has been carried out well. The feasibility validation form, readability form, and student questionnaire form were analyzed descriptively and quantitatively to collect the data. From the results, it was obtained the results of the feasibility validation of the textbook with a percentage of 89.40%, the results of the assessment of the readability of the textbook with a percentage of 89%, and the results of students' responses to the textbook with a percentage of 86.66%. Overall, the textbook with ethnomathematics nuances at the Masjid Al Mahdi Magelang is feasible and easy to understand. It is ready to be implemented in learning mathematics in 8th grade.

Keywords: Discovery Learning; Ethnomathematics; Reasoning Ability; Textbook.

A. Introduction

Indonesia is a nation that has thousands of wealth spread from Sabang to Merauke, with a lot of cultures that are owned, namely in the form of customs, musical instruments, regional clothing, regional songs, and so on. According to Koentjaraningrat (2009), culture is the entire system of ideas, actions, and human works in the context of community life made human by learning. Culture-based learning is a learning approach model that prioritizes the activities of students with various cultural backgrounds and integrates them into the learning process of specific fields of study and the assessment of learning outcomes (Fahrurrozi, 2015). Education is one of the discussions that will continue. This is based on the fact that education is essential in building a country.

Educational programs for learning in schools are influenced by several factors, including students, curriculum, costs, academic staff, facilities and infrastructure, and environmental factors. If these factors are met, then the learning process runs smoothly. Furthermore, learning mathematics focuses on developing how to think and work mathematically so as to develop

students' mathematical abilities (Zevenbergen, Dole, & Wright, 2004; Suherman, 2003; Hudojo, 2003; Junaedi & Asikim 2012).

Mathematical abilities for students have a vital role in providing knowledge skills and forming attitudes and mindsets to preserve and develop the role of mathematics itself (Darwanto, 2019). One of the essential parts of mathematics is a flat shape or, more fully, a quadrilateral. Mathematical reasoning is the foundation for obtaining or constructing mathematical knowledge. According to Putri, Sulianto & Azizah (2019), mathematical reasoning is a necessary and essential ability for students. The importance of having mathematical reasoning abilities in students is basically in line with the vision of mathematics, especially to meet future needs.

Unfortunately, students mathematical reasoning in Indonesia are still low. The results of PISA stated that around 71% of Indonesian students do not reach the minimum competency level of math (Pusat Penilaian Pendidikan Balitbang Kemendikbud, 2019). It's mean that there are still many Indonesian students who have difficulty dealing with situations that require mathematical reasoning skills.

Reasoning ability is one of the abilities to be achieved through the Discovery Learning model. The Discovery Learning Model is one of the learning models where the teacher does not provide the final results or conclusions from the material presented; instead, the teacher allows students to search for and find the results of the data so that the learning process is more meaningful and easy to remember by students and learning outcomes what is obtained is not easily forgotten (Prasasty & Utaminingtyas, 2020).

Textbooks are material/subject matter that is arranged systematically and used by teachers and students to achieve the expected goals. The development of textbooks can be used as an alternative solution to overcome students' difficulties in solving mathematical problems. Developed textbooks need to contain processes and strategies that make solving math problems easier (Siniguian, 2017). This textbook was developed with an ethnomathematics approach to building the Masjid Al-Mahdi Magelang and quadrilateral material. Ethnomathematics is a mathematics learning using an approach to culture.

Ethnomathematics is also a particular method related to culture in mathematical activity (Rahmawati & Muchlian, 2019). The Masjid Al Mahdi is a Magelang City building closely related to ethnomathematics. In this Masjid Al Mahdi, some buildings are quadrilateral in shape, which are mathematics subject matter. The Masjid Al Mahdi is a place of worship for Muslim residents around the mosque. The forms in the mosque can be used as an ideas for learning mathematics.

Learning mathematics regarding the forms in the Masjid Al Mahdi building can be carried out in teaching and learning activities. It can be carried out as a reference to the material. Mathematics learning also becomes more interesting by utilizing the Masjid Al Mahdi building. With this ethnomathematics textbook, it is hoped that it will be easier for teachers to carry out learning and students will be more assisted in learning mathematics and easy to understand the material explained.

Some researchers have done several research about the integration of ethnomathematics in geometry. Massarwe, Verner, & Bshouty (2010) integrated some ornaments as an ethnomathematics exercise in a geometry class, including the quadrilateral material. Pramudita & Rosnawati (2019) find that Javanese culture ethnomathematics like Batik and Joglo are

related to quadrilateral material. Furthermore, Wulandari, et al. (2022) have been developed an elementary triangle and quadrilateral mini book based on the ethnomathematics of Candi Gedong Songo. This development is used as a reference of this study.

Based on this problem, this study aimed to develop a textbook based on Discovery Learning with ethnomathematics nuances at the Masjid Al Mahdi Magelang on students' reasoning abilities to assist students in learning mathematics on quadrilateral material. The developed textbook is expected to improve students' mathematical reasoning abilities.

B. Methods

Research and development are carried out to develop products using a 4D model that is modified into 3D, consisting of Define, Design, and Develop stages. The define stage includes an integrated activity to indentify the characteristics of textbook. In the design stage, the prototype of the textbook was develop. The develop stage ensures the textbook is feasible, easy to understand, and it has a good response from students. Furthermore, this activity is presented in the Figure 1.

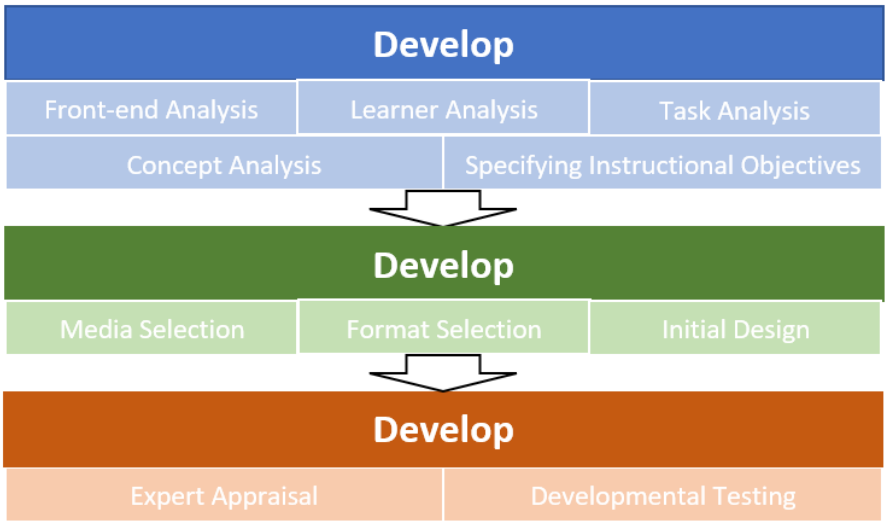


Figure 1. 3D stages for Developing Textbook

This research involved students which is around the Masjid Al Mahdi, Magelang. Some practitioners are also involved in this research. This is done to obtain valid and relevant data related to textbook development.

Several forms were used in research, such as the feasibility assessment form, the readability assessment form, and student response questionnaires as data collection techniques. Experts and practitioners carry out feasiblity assessments. Several students who have studied this material carried out the readability assessment and several students were studying the material responses for the student responses. The Likert scale assesses feasibility, while the Guttman scale assesses readability and student responses.

The data collection results were then analyzed to obtain a percentage score for each assessment. The results of the percentage scores are then represented based on several criteria presented in Table 1. The product is feasible, easy to understand, and has good student responses if the minimum percentage score is 85%.

Table 1. Score Percetage Categorization

Interval Percentage	Category
$85\% < x \leq 100\%$	Very Good
$70\% < x \leq 85\%$	Good
$60\% < x \leq 70\%$	Acceptable
$50\% < x \leq 60\%$	Not good
$0\% < x \leq 50\%$	Very not good

C. Results and Discussion

Research and development have been carried out using a 3D model of Define, Design, and Develop to obtain a textbook ready to be implemented in classroom learning for quadrilateral material for class VII junior high school students. This textbook is expected to be an additional reference for teachers in providing quadrilateral material. The 3D activity has been well executed for each sub-activity. The following is a description of each activity and sub-activity.

1. Define Stage

The Define stage aims to determine and define the requirements needed in learning by analyzing the objectives and limitations of the material developed in the textbook. According to Thiagarajan, Semmel, & Semmel (1974), in the Define stage, there are five main points, namely (a) front-end analysis, (b) student analysis, (c) concept analysis, (d) task analysis, and (e) formulation of learning objectives.

Front-end analysis was carried out to observe and find information about the problems experienced by learning mathematics, so it is necessary to develop this textbook (Thiagarajan, Semmel, & Semmel, 1974). In this research, efforts were made to improve the quality of student learning outcomes with learning activities using an ethnomathematics-based textbook at the Masjid Al Mahdi Magelang on quadrilateral material.

The next activity is student analysis, which is carried out by observation to determine student characteristics, which include students' initial abilities and obstacles experienced by students in learning mathematics. The results of the observation activities were that class VII students still had difficulty understanding quadrilateral material. These difficulties are in line with Darlia, La Arapu, & Rosdiana's findings (2016) where students experience learning disorders, learning disabilities, learning dysfunction, low achievement and slow learning. This is also the basis for choosing the suitable learning model to overcome student difficulties. This textbook will use the Discovery Learning Model as a learning model. Discovery Learning is a learning model in which students are expected to understand the origin or concept of the material being taught. In addition, student analysis activities were also carried out by interviewing one of the students about the relationship between the Masjid Al Mahdi building and learning mathematics on quadrilateral material. The results obtained in an interview with

one of the students were that students did not know the relation between mosque buildings and learning mathematics.

Concept analysis is carried out to find out the main concepts taught in the material that will be developed in a textbook. This activity was carried out by collecting learning resources from the Buku Pegangan Siswa Kurikulum 2013 and Student Worksheets. This activity was carried out through literature reviews and field studies regarding the building of the Masjid Al Mahdi Magelang. Figure 1 shows the mosque building related to quadrilateral material. Figure 2 (a) and 2 (b) (which are marked in red) show buildings that are similar to the flat shapes studied in mathematics, namely trapezoids and rectangles. In addition to these buildings, there are still several buildings with square, rhombus, and parallelogram shapes.

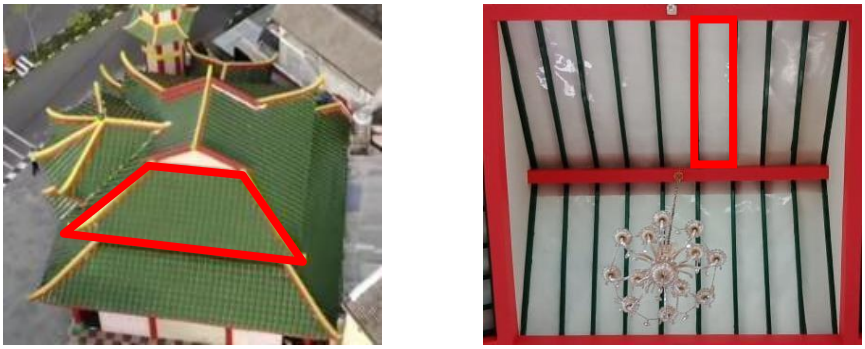


Figure 2. (a) The Roof form Outside, (b) The Roof form Inside

The next activity is task analysis, which identifies skills or abilities that researchers will study. The abilities that will be displayed in this textbook are students' reasoning abilities. The last activity in the defining stage is the formulation of learning objectives adjusted to indicators of competency achievement. The formulation of objectives is based on the results of the analysis of concepts and assignments, which then become the basis for compiling and designing a textbook that is then integrated into the material that has been determined in the development of the textbook. The formulation of learning objectives is based on the basic competencies and indicators of achievement of predetermined competencies. The following results are obtained related to basic competencies and competency achievement indicators.

Table 2. Basic Competencies and Competency Achievement Indicators

Basic Competencies	Competency Achievement Indicators
3.11 Associating the perimeter and area formulas for various types of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite), and triangles.	3.11.1 Identify the different types of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite). 3.11.2 Finding the area of a quadrilateral (square, rectangle, rhombus, parallelogram, trapezoid, and kite).
4.11 Solving contextual problems related to areas and perimeters and quadrilaterals (squares, rectangles, rhombuses, parallelograms, trapezoids, and kites), and triangles.	4.11.1 Solve contextual problems related to the perimeter of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite). 4.11.2 Solving contextual problems related to the area of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite).

2. Design Stage

The second stage in developing this product is to design a textbook with an Ethnomathematics nuance by the Discovery Learning Model that can be created using students' reasoning abilities. At this stage, several steps are taken, namely, making a textbook cover design, making a design for instructions to use textbooks and explanations of learning models, making designs and contents of motivational pages, and making an arrangement of textbook material. The follow-up to the results of the study report on cultural exploration in the surrounding environment that contributes to learning mathematics was compiled into an initial design of a textbook (draft 1). Figure 3 shows the initial design of the textbook with ethnomathematics nuances.

Figure 3. (a) Textbook Cover, (b) Quadrilateral Materials, (c) Competence Tests

3. Develop Stage

At this stage, several sub-activities are carried out. Feasibility validation is the first sub-activity through assessments from experts and practitioners. Several students carried out readability assessments as the second sub-activity. Student responses are carried out as the last sub-activity to ascertain how students respond to the product being developed.

There is feasibility validation to ensure the textbook is feasible to be implemented in learning mathematics. The results of the validation of the textbook that has been carried out are as follows. Experts and practitioners have carried out the validation. The textbook's feasibility validation was carried out based on three aspects, namely the content feasibility aspect, the presentation feasibility aspect, and the linguistic aspect. In the aspect of content feasibility, there are four assessment indicators, namely (1) the suitability of the material with basic competencies, indicators of achievement of competencies, and learning objectives, (2) the accuracy of the material, (3) supporting learning materials, (4) updating of the material. In the aspect of presentation feasibility, there are four assessment indicators, namely (1) presentation technique, (2) presentation support, (3) learning presentation, and (4) presentation completeness. In the linguistic aspect, there are six assessment indicators, namely (1) straightforward, (2) commutative, (3) dialogic and interactive, (4) conformity with the level of student development, (5) coherence and integration of thought flow, (6) use of terms, symbols

or icon. Based on the feasibility validation by experts and practitioners, the textbook's feasibility validation results are presented in Tables 3 and 4.

Table 3. Expert Validation Results

Aspect Assessed	Max	P01	P02	P03	Criteria
Content Feasibility	104	102	86	97	Very Good
Presentation Feasibility	60	59	50	58	
Linguistic	56	44	44	53	
Final Score (%)	100	93.18	81.82	94	
Mean		89.66			

Table 4. Practitioner Validation Results

Aspect Assessed	Max	P01	P02	P03	Criteria
Content Feasibility	104	99	80	99	Very Good
Presentation Feasibility	60	59	45	58	
Linguistic	56	52	42	56	
Final Score (%)	100	95.45	75.90	96.81	
Mean		89.38			

Based on these results, the validation scores for each expert were 93.18%, 81.82%, and 94%, with an average of 89.66%. These results are included in the criteria for a very feasible textbook. Furthermore, the validation scores for each practitioner were 95.45%, 75.90%, and 96.81%, with an average of 89.38%. These results are included in the criteria of a very feasible textbook. If the average final score of expert and practitioner validation is obtained, a final score of 89.52% is obtained with a textbook in the very feasible category. These results indicate that the textbook based on ethnomathematics at the Masjid Al Mahdi Magelang on quadrilateral material is ready to be implemented in the classroom.

Before being implemented in the class, the textbook must be tested for development. This is done to get input or suggestions so that consistent and effective textbooks can be used in classroom learning. This trial was aimed at three grade VII junior high school students as textbook targets. Previously, five students of the mathematics education study program carried out a readability test. In validating the readability assessment of textbook carried out by students, there are ten assessment points, namely (1) the textbook uses language (vocabulary, sentences, paragraphs, and discourse that is easy to understand), (2) the form of writing and the font size used is transparent, so that makes it easy to read a textbook, (3) the width of the spacing used makes it easy to read a textbook, (4) there are no writing errors in a textbook, (5) the graphical aspects used in a textbook is interesting, (6) the presentation of a textbook is interesting according to with the material and age of the readers (students), (7) the textbook uses an exciting writing style, (8) the density of ideas and information contained in the reading (length of short sentences) is easy to understand, (9) the textbook already uses standard Indonesian grammar, (10) the systematic presentation of material on textbook facilitates understanding of the reader. Based on legibility validation by students and textbook responses by students, the analysis results are presented in Table 5. Based on these results, the average final readability test score was 89% with easy-to-understand textbook representations. These results indicate that the ethnomathematics-based textbook at the Masjid Al Mahdi Magelang on quadrilateral material is easy to understand in terms of readability.

Table 5. Readability Validation Results

Aspect Assessed	Max	P01	P02	P03	P04	P05	Criteria
Score	40	39	32	35	38	34	Very Good
Final Score (%)	100	97.5	80	87.5	95	85	
Mean				89			

The last sub-activity is assessing student responses. Student responses need to be considered to ensure their learning needs. The results of the assessment of student responses are presented in Table 6. Based on these results, the average final score of student responses to the textbook was 86.66%. From the responses written by students, overall, the textbook is easy for students to understand. However, there is still something that needs to be improved in the color composition to clarify the writing in the textbook.

Table 6. Student Respone Quetionnaire Results

Evaluator	Score	Final Score (%)	Student's Respone
S01	15	75	There are color compositions that do not match, causing the writing to not be seen clearly, it is better to pay attention to the color composition of textbook
S02	17	85	The textbook are good and the material is also easy for me to understand.
S03	20	100	The textbook are easy for me to understand
Mean	17.33	86.66	

Research in the form of developing an ethnomathematics-based textbook through the building of the Masjid Al Mahdi Magelang on quadrilateral material is a solution to students' reasoning ability. Students' difficulty in solving contextual problems is the right solution in developing this textbook because this textbook provides contextual problems with problem-solving that is easy for students to understand.

The development of this textbook goes through three stages, namely the define stage, the design stage, and the develop stage. There are five stages in the define stage: front-end analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. The design stage, which includes making the cover design for the textbook, designing instructions for using the textbook and explaining learning models, making designs and contents of motivational pages, and making textbook material arrangements, is a follow-up to the definition stage so that an initial design of ethnomathematics-based textbook is made. Ready to be tested. The final stage of this research is the development stage which includes validation of feasibility by experts and practitioners with revisions, validation of readability by students with corrections, and validation of student responses with corrections.

The validation study of the textbook feasibility test provides certainty about the quality of the textbook being developed. The aspects of content feasibility, presentation feasibility, and language that have been validated and given an assessment provide certainty that the textbook is feasible to implement. In addition, students' validation of the readability test provides certainty for textbooks developed in the easy-to-understand textbook category. These results mean that the textbook is ready to be implemented in classroom learning.

However, from the textbook, there are still deficiencies, including (a) the questions that are developed are not open ended¸ (b) the quadrilateral material presented does not cover everything, only covers parallelograms, rectangles, squares, rhombuses, and trapezoids, (c) the material presented is only the perimeter and area of the rectangle. However, with these results, textbooks with ethnomathematics nuances at the Masjid Al Mahdi Magelang are feasible to implement in learning mathematics for class VII. From the results of the feasibility validation with the suggestions and input provided, the textbook was perfected, and a final draft was produced and ready to be implemented in class. In addition, textbooks with ethnomathematics nuances at the Masjid Al Mahdi Magelang are prepared to be used as learning tools that are easy to use and easily understood by students, with the hope of being able to improve learning outcomes and students' reasoning abilities and textbook with ethnomathematics nuances at the Masjid Al Mahdi Magelang are ready to be used by students in math learning. This finding is in line with what was conveyed by Helaluddin (2018) which mentions the theory of essentialism related to culture-based education, which in this study is referred to as Ethnomatematics.

Student responses to the questionnaire results were very positive, and students were interested in using the textbook to learn mathematics. Based on the validation results of the assessment of the feasibility of the textbook, the assessment of the readability of the textbook, and students' responses to the textbook, it was found that the textbook was in the very good and easy-to-understand category. Hence, they were ready to be implemented in mathematics learning for 8th grade. With the excellent validity and readability of this textbook, it will undoubtedly help students understand quadrilateral material in which students are also required to improve their reasoning abilities supported by examples and questions in the category of reasoning ability questions. This textbook was developed using the Discovery Learning Model for students' reasoning abilities. The application of the Discovery Learning Model will undoubtedly help students improve their reasoning abilities because this model requires students to understand the concept from the start, with the discovery process carried out directly by the students themselves (Burais, Ikhsan, & Duskri, 2016).

Ethnomathematics is a field that studies how people from different cultures understand, pronounce and use concepts from their culture related to mathematics so that in mathematics, it can be learned how to understand, express, and use cultural concepts that are described mathematically (Hariastuti, 2017). It is noted that Ethnomatematics integration can achieve student learning success (Suwito & Trapsilasiwi, 2016; Ferdianto & Setiyani, 2018). The development of a textbook with an ethnomathematics nuance does carry not only mathematics education but also a culture that will make the teaching and learning process more meaningful because students not only receive mathematics material but also get to know the local culture that exists around the students' environment (Nelawati et al., 2018). Several successes of textbooks with Ethnomatematics nuances have been recorded for achieving the goals of learning mathematics among students, including among students' reasoning abilities. (Ayuningtyas & Setiana, 2019; Ramadhani & Dewi, 2022). This follows the textbook the researchers developed, in which students' reasoning abilities are expected to increase with this nuanced Ethnomathematics textbook. The ethnomathematics-based mathematics module using the Discovery Learning Model will help students more easily understand the material presented and can engage students in discovery activities, learning that is interesting and fun, and invites

students to think critically and actively (Fitriyah, Santoso, & Suryadinata, 2018; Sartika & Makmur, 2020). As with textbooks developed by researchers, by applying the Discovery Learning Model, it is hoped that students will more easily understand quadrilateral material, and student learning outcomes can increase.

D. Conclusion

Based on the research, it was determined that the developed textbook was feasible to implement in mathematics learning. It was shown from the results of the feasibility assessment of the textbook, which received a percentage of 89.40%, and an assessment of readability which received a percentage of 89%. From the results of the feasibility and readability assessment of the textbook, it is hoped that it will make it easier for students to understand the material contained in the textbook. In addition to this assessment, the developed textbook has received a response from students with a percentage obtained of 86.66%, so from the results of the student's response, it can be interpreted that the textbook has an appeal for students. Overall, the textbook with ethnomathematics nuances at the Masjid Al Mahdi Magelang is ready to be implemented in learning mathematics in class VII. Therefore, it is hoped that the development of another textbook at the Masjid Al Mahdi Magelang can be arranged to cover all quadrilateral material.

References

Ayuningtyas, A. D. & Setiana, D. S., (2019). Pengembangan Bahan Ajar Matematika Berbasis Etnomatematika Kraton Yogyakarta. *AKSIOMA (Jurnal Program Studi Pendidikan Matematika),* 8(1), 11-19.

Burais, L., Ikhsan, M., & Duskri, M. (2016). Peningkatan kemampuan penalaran matematis siswa melalui model discovery learning. *Jurnal Didaktik Matematika,* 3(1), 77-86.

Darlia, La Arapu. & Rosdiana, (2016). Deskripsi Kesulitan Belajar dalam Menyelesaikan Soal-Soal Matematika Materi Pokok Keliling dan Luas Segiempat di Kelas VII SMP Negeri 6 Kendari. *Jurnal Penelitian Pendidikan Matematika,* 4(1), 29-41

Darwanto, D., (2019). Hard Skills Matematik Siswa. *Eksponen*, 9(1), 21-27.

Fahrurrozi, M. (2015). *Pembelajaran Berbasis Budaya: Model Inovasi Pembelajaran dan Implementasi Kurikulum Berbasis Kompetensi*. Malang: Surya Pena Gemilang.

Ferdianto, F., & Setiyani, S. (2018). Pengembangan bahan ajar media pembelajaran berbasis kearifan lokal mahasiswa pendidikan matematika. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 2(1), 37-47.

Fitriyah, D. N., Santoso, H., & Suryadinata, N. (2018). Bahan ajar transformasi geometri berbasis discovery learning melalui pendekatan etnomatematika. *Jurnal elemen*, 4(2), 145-158.

Hariastuti, (2017). Permainan tebak-tebak buah manggis: Sebuah inovasi pembelajaran matematika berbasis etnomatematika. *Jurnal Matematika dan Pendidikan Matematika,* pp. 25-35.

Helaluddin, (2018). Restrukturisasi Pendidikan Berbasis Budaya: Penerapan Teori Esensialisme di Indonesia. *JDPP (Jurnal Dimensi Pendidikan dan Pembelajaran),* 06(02), 74-82.

Hudojo, H. (2003). *Pengembangan Kurikulum dan Pembelajaran Matematika*. Surabaya: UM Press

Junaedi, I. & Asikin, M. (2012). Pengembangan Pembelajaran Matematika Humanistik Untuk Meningkatkan Kemahiran Matematis. *Unnes Journal of Mathematics Education Research*, 1(2), 114-120.

Koentjaraningrat. (2009). *Pengantar Ilmu Antropologi*. Jakarta: Rineka Cipta

Massarwe, K., Verner, I., Bshouty, D., & Verner, I. (2010). An ethnomathematics exercise in analyzing and constructing ornaments in a geometry class. *Journal of Mathematics and Culture*, 5(1), 1-20.

Nelawati, N., Meriyati, M., Putra, R. W. Y. & Simatupang, A. T., (2018). Pengembangan Bahan Ajar Bercirikan Etnomatematika Suku Komering Materi Bangun Datar Siswa Sekolah Dasar. *Prosiding Seminar Nasional matematika dan Pendidikan Matematika*, 01(02), 407-414.

Pramudita, K., & Rosnawati, R. (2019, March). Exploration of Javanese culture ethnomathematics based on geometry perspective. In *Journal of Physics: Conference Series* (Vol. 1200, No. 1, p. 012002). IOP Publishing.

Prasasty, N. and Utaminingtyas, S., (2020). Penerapan Model Discovery Learning Pada Pembelajaran Matematika Siswa Sekolah Dasar. Jurnal Riset Pendidikan Dasar (JRPD), 1(1), 57-64

Pusat Penilaian Pendidikan Balitbang Kemendikbud. 2019. *Pendidikan di Indonesia Belajar Dari Hasil PISA*. Jakarta: Kemendikbud

Putri, D. K., Sulianto, J., & Azizah, M. (2019). Kemampuan Penalaran Matematis Ditinjau dari Kemampuan Pemecahan Masalah. *International Journal of Elementary Education*, 3(3), 351-357.

Rahmawati, Y., & Muchlian, M. (2019). Eksplorasi etnomatematika rumah gadang minangkabau Sumatera Barat. *Jurnal Analisa*, 5(2), 123-136.

Ramadhani, Y. G., & Dewi, N. R. (2022, February). Kajian Teori: Pengembangan Bahan Ajar Berbasis Etnomatematika untuk Meningkatkan Kemampuan Penalaran Siswa Kelas VIII Materi SPLDV dengan Model Pembelajaran Auditory, Intellectually, Repitition (AIR). In *PRISMA, Prosiding Seminar Nasional Matematika* (Vol. 5, pp. 500-506).

Sartika, I. & Makmur, A., (2020). Pengembangan Modul Pembelajaran Matematika Berbasis Etnomatematika Menggunakan Metode Discovery. *PeTeka (Jurnal Penelitian Tindakan Kelas dan Pengembangan Pembelajaran*, 03(02), 122-126.

Siniguian, M. T. (2017). Students difficulty in solving mathematical problems. *International Journal of Advanced Research in Engineering and Applied Sciences*, 6(2), 1-12.

Suherman, et al. (2003). *Strategi Pembelajaran Matematika Kontemporer*. Bandung: JICA

Suwito, A., & Trapsilasiwi, D. (2016). Pengembangan model pembelajaran matematika SMP kelas VII berbasis kehidupan masyarakat JAWARA (Jawa dan Madura) di Kabupaten Jember. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, 4(2), 79-84.

Thiagarajan S, Semmel DS & Semmel MI. (1974). *Instructional Development for Training Teachers of Exceptional Children: a Sourcebook*. Bloomington: Indiana University

Wulandari, H. U., Aminah, R., Laviona, Z., & Ardiansyah, A. S. (2022). Development of Elementary Triangle and Quadrilateral Mini Book based on the Ethnomathematics of Candi Gedong Songo. *International Journal of Advanced Mathematics Education*, 3(3).

Zevenbergen, R., S. Dole & R. J. Wright. (2004). *Teaching Mathematics in Primary Schools*. New South Wales: National Library of Australia

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 13-24
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

Influence of *Guided Discovery Learning* Models on Eighth Grade Students' Mathematical Creative Thinking Ability

Septy Faiqotul Amany[1]✉, Miatullabibah[2]

[1]*Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto, Purwokerto, Indonesia*
[2]*Universitas Muhammadiyah Purwokerto, Purwokerto, Indonesia*

✉ *Corresponding email: septyfaiqotul149@gmail.com*

Received May 29, 2023
Accepted June 27, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8446

Abstract: The background of this research is the low ability to think creatively mathematically in class VIII students at MTs Ma'arif NU 04 Tamansari because the teacher's learning uses the lecture method, where students only pay attention to explanations, so students are less interested in learning and have difficulty understanding the material. Therefore, researchers use learning models that can improve students' creative thinking abilities, one of which is the Guided Discovery Learning learning Model. The Guided Discovery Learning Learning Model is a learning model that prioritizes students' activity in processing information or learning materials through guidance from the teacher and collaboration between students. The research design used in the study was the pre-test and post-test control group. In this study, the population taken as students of grade VIII MTs Ma'arif NU 04 Tamansari, namely grade VIII A, VIII B, VIII C, VIII D, and VIII E. While the sample was grade VIII B and VIII C. The sampling in this study using the technique of Convenience Sampling (Desirability Sampling). The data collection technique used in this study was in the form of essay tests in the form of pre-test and post-test. Data analysis techniques using the T-test. The results of this study show that the Guided Discovery Learning learning model was carried out very well and the Guided Discovery Learning model influences the students' ability to think creatively mathematically in grade VIII.

Keywords: creative thinking; guided discovery learning; mathematics.

A. Introduction

In the learning process, students must have the ability to solve mathematical problems. With these abilities, students will gain a deeper understanding of mathematics and the goals of education will be achieved and developed. One of the mathematical solving abilities that students must have is the ability to think creatively. Creative comes from the English word Create which means to create, creative means to have creativity, to be able to realize ideas and feelings so as to create a composition with a new atmosphere and circumstances (Marliani, 2015:17). So, it can be concluded that the ability to think creatively mathematically is an ability possessed by students to solve mathematical problems easily, simply,

The ability to think can be done well, if there is a strong reasoning power so as to produce a skill to act with the intelligence of the students themselves. Students will be able to generate unexpected ideas and get different points of view, if they have the ability to think creatively. The ability to think creatively mathematically can bring up various kinds of solutions in mathematical problems (Utami, 2020: 45). Mathematical creative thinking is an ability that includes originality, fluency, flexibility, and elaborations. Indicators of mathematical creative

thinking ability include: Fluency (fluent thinking skills), Flexibility (flexible thinking skills), Originality (original thinking skills), and Elaboration (detailing skills) (Utami, 2020: 45).

The factors that can influence students' mathematical creative thinking abilities are internal factors and external factors. Internal factors that can affect the ability to think creatively mathematically is the initial ability of the students themselves. That is, the abilities that students already have before the learning process is carried out. Students who have high thinking skills are more likely to easily receive material or understand material. While the external factors that influence students' mathematical creative thinking abilities are the learning process in the selection of learning models by the teacher. In addition to the external factors described above, there are other factors that can affect students' mathematical creative thinking abilities, namely motivation,

The ability to think creatively mathematically must be owned by students at every level, because mathematics is always there at every level of education. Mathematics is very important for everyday life, so it is necessary to have the ability to think creatively to solve math problems, but most students think that mathematics is complicated, difficult, and scary so that students are difficult to understand math material. Students' mathematical creative thinking abilities cannot develop properly if in the learning process the teacher does not involve students to be active in concept formation (Andiyana, 2018: 241).

The phenomenon of students' low creative thinking ability often occurs at all levels of education. This low ability can be demonstrated by the results of the 2015 PISA (Program for International Student Assessment) which placed Indonesia in 63rd place out of 70 countries. Likewise the results of TIMSS (The Trend International Mathematics and Science Study) in 2015, Indonesia was ranked 45th out of 50 countries (Putri, 2020:15). This phenomenon can be found in students at MTs Ma'arif NU 04 Tamansari who on average have low mathematical creative thinking abilities. During the interview conducted by the researcher with the resource person, the teacher who teach in that school, information was obtained that students' creative thinking abilities were still low because when exams or assignments were held, how to solve students still use the usual method or not varied. Student completion is not varied because when learning the teacher uses the lecture method, where students only pay attention to explanations, so students are less interested in learning and have difficulty understanding the material. The existence of these events, causing students to be more likely to be passive so that when solving math problems they experience difficulties. The learning process using the lecture method will make students not active in learning. The lack of varied learning methods can affect students' learning interest and will affect students' mathematical creative thinking abilities which become low. Student completion is not varied because when learning the teacher uses the lecture method, where students only pay attention to explanations, so students are less interested in learning and have difficulty understanding the material. The existence of these events, causing students to be more likely to be passive so that when solving math problems they experience difficulties. The learning process using the lecture method will make students not active in learning. The lack of varied learning methods can affect students' learning interest and will affect students' mathematical creative thinking abilities which become low. Student completion is not varied because when learning the teacher uses the lecture method, where students only pay attention to explanations, so students are less interested in learning and have difficulty understanding the material. The existence of these events, causing students to be

more likely to be passive so that when solving math problems they experience difficulties. The learning process using the lecture method will make students not active in learning. The lack of varied learning methods can affect students' learning interest and will affect students' mathematical creative thinking abilities which become low. causing students to be more passive so that when solving math problems they experience difficulties. The learning process using the lecture method will make students not active in learning. The lack of varied learning methods can affect students' learning interest and will affect students' mathematical creative thinking abilities which become low. causing students to be more passive so that when solving math problems they experience difficulties. The learning process using the lecture method will make students not active in learning. The lack of varied learning methods can affect students' learning interest and will affect students' mathematical creative thinking abilities which become low.

With the phenomenon of low students' mathematical creative thinking abilities, an innovative learning model is needed to develop students' mathematical creative thinking abilities. Choosing the right learning model for students will make learning less boring and more conducive, besides that it can affect students' achievement in learning mathematics. The learning process in class can be said to be good if it uses a learning model that involves active students and can participate in the learning process (Yusniawati, 2015: 88). One of the objectives of the existence of a learning model is to manage learning in class so that it is more effective and directed so as to be able to improve students' abilities to support successful learning, namely in the ability to think creatively mathematically.

One learning model that can increase student activity so that students' creative thinking skills will increase, namely the Guided Discovery Learning learning model. Guided Discovery is a form of discovery learning method which is one of the most influential cognitive instructional models from Jerome Brunner. According to Bruner, discovery learning is in accordance with the active discovery of knowledge by humans and by themselves being able to produce something good. Whereas Guided Discovery according to Brunner is that students are given a problem to find a solution to and the teacher only shows, directs, provides feedback and provides examples to guide students to easily solve a problem (Sapitro, 2012: 5).

From the above understanding, it can be concluded that the notion of the Guided Discovery Learning Learning Model is a learning model capable of creating learning situations that involve students being able to learn actively and independently in solving a problem and discovering a concept and theory, while the teacher is a facilitator and guide for the course of the learning process (Riyanti , 2018: 3). The application of the GDL learning model can provide a conducive and pleasant classroom atmosphere so that students can learn actively and are able to find formulas for solving mathematical problems creatively and innovatively. With this model, students will easily understand the material optimally and create a class atmosphere that is not boring. Therefore, the existence of a learning model is needed to improve the ability to think creatively. This model will provide broad opportunities for students to process and play an active role in learning. The stages in the guided discovery learning learning model include: Orientation, Hypothesis Generation, Conclution phase, and Regulation phase (Rini, 2021:25).

The advantages and disadvantages of the Guided Discovery Learning learning model. The advantages of this learning model are that it can help students to develop their own abilities and readiness to learn as well as mastery of skills in their cognitive processes, students gain

knowledge independently so that this knowledge will be more meaningful and can give students confidence in solving problems because this learning model focuses on independence student. While the drawbacks are that students must have readiness and mental maturity, it is not effective if it is applied in a fat class, and if the class is already accustomed to the old style learning model or conventional model then it will not be interested in the guided discovery learning model.

Based on this explanation, the author wants to conduct research that aims to describe the quality of the application of the Guided Discovery Learning model and to find out whether there is an effect of the Guided Discovery Learning model on the ability to think creatively mathematically in class VIII students.

B. Method

The approach applied is a quantitative approach. Using test instrument which done by students both before and after the study to get the data. Beside that, observation sheet is also use to observe the student's activity. The research design used in the study was the Pretest and Posttest Control Group. The research was started by giving a pretest to the experimental class and control class, then giving mathematics learning to the experimental class using the guided discovery learning model and the control class using the lecture method. After carrying out the entire learning series, the two classes were given a posttest with the aim of knowing the increase in students' mathematical creative thinking abilities.

In this study, the population taken was class VIII students at MTs Ma'arif NU 04 Tamansari in the academic year 2022/2023, which consisted of 5 classes, namely classes VIII A, VIII B, VIII C, VIII D, and VIII E. In this study, the sample taken are 2 classes (experimental class and control class). The researcher made class VIII B as the control class and class VIII C as the experimental class. Sampling in this study used the Convenience Sampling technique (Desire Sampling). The method of data analysis is by implementing analysis and analyzing the influence of the learning model by using the normality test, homogeneity test, and T test (hypothesis) with the help of *software SPSS Version 25.*

C. Results and Discussion

1. Research Result

This research begins by testing the instrument with content validation and item validation. This content validation was carried out by expert opinion by looking at the feasibility of the research instrument which includes the suitability of the material, appropriate language, and construction. The results of the analysis from the validator, namely 3.35, are included in the interval$3{,}25 \leq x \leq 4{,}00$. So from the validator it can be concluded that mathematical creative thinking questions are appropriate for use in research with the criteria of "Very Valid". As for the validation of the item items, this is done by instrument testing with assistance *software SPSS Version 25.*By using the assisted product moment correlation formula *software SPSS Version 25* generated as Table 1.

Table 1. Test Results for the Validity of Pre-Test Items

No. Items	rcount	Rtable	Information

1	0.430	0.3739	Valid
2	0.466	0.3739	Valid
3	0.415	0.3739	Valid
4	0.497	0.3739	Valid
5	0.291	0.3739	Invalid
6	0.495	0.3739	Valid
7	0.648	0.3739	Valid
8	0.423	0.3739	Valid

From the table above it can be seen that of the 8 questions, one of them is invalid, namely at number 5. Invalid item numbers cannot be used for research so they must be removed. Meanwhile, item numbers that are declared valid are still used to obtain data needed for research. So, the number of valid questions in this study totaled 7 questions, each item representing one indicator, namely questions number 1, 3, 6, and 8.

Table 2. Results of the validity test of the post-test items

No. Items	rcount	rtable	Information
1	0.554	0.3739	Valid
2	0.600	0.3739	Valid
3	0.651	0.3739	Valid
4	0.633	0.3739	Valid
5	0.620	0.3739	Valid
6	0.653	0.3739	Valid
7	0.702	0.3739	Valid
8	0.696	0.3739	Valid

From the Table 2 can be seen that all items are declared valid. So, in this study using all item questions by selecting numbers 1, 3, 5, 7 which represent one indicator.

Then donereliability testing, can use Cronbach's Alpha formula. The reliability test calculation was carried out with the help of the SPSS Version 25 application. The results of the Cronbach's Alpha reliability test on the pre-test questions can be seen in Table 3.

Table 3. Reliability Test Results Creative Thinking Ability Pretest Questions

Reliability Statistics	
Cronbach's Alpha	N of Items
,835	8

The table above shows that the Cronbach's Alpha value of the instrument for the ability to think creatively in the pre-test questions is 0.835, which means the reliability coefficient is $>$ 0.60 so it can be concluded that the instrument for the variable ability to think creatively in the pre-test questions is reliable.

Table 4. Reliability Test Results Creative Thinking Ability Posttest Questions

Reliability Statistics	
Cronbach's Alpha	N of Items
,857	8

The table above shows that the Cronbach's Alpha value of the instrument for the ability

to think creatively in the post-test questions is 0.857, which means the reliability coefficient is > 0.60 so it can be concluded that the instrument for the variable ability to think creatively in the post-test questions is reliable. After testing the validity and reliability tests, data analysis is carried out, which is an activity after data from all respondents or other data sources have been collected. The activity in question is to carry out calculations to answer the problem formulation and perform calculations to test the hypotheses that have been proposed (Sugiyono, 2019: 206).

a. Implementation of The Guided Discovery Learning Model

The assessment was given to determine the ability of researchers to manage mathematics learning in the experimental class based on observations from observers 1 and 2. The level of research ability in teaching was calculated by adding up the total score and then dividing the number of aspects in the observation/observation sheet. For categorizing the ability of researchers, the following criteria are used:

Table 5. Criteria for the ability of researchers in learning with the guided discovery learning model

Ability Level	Criteria
$3{,}25 \leq x \leq 4{,}00$	Very good
$2.50 \leq x < 3{,}25$	Good
$1.75 \leq x < 2{,}50$	Pretty good
$1.00 \leq x < 1{,}75$	Not good

The results of observing learning with the Guided Discovery Learning learning model carried out by observer 1 and observer 2 namely

Table 6. Learning Observation Results Model Guided Discovery Learning

No	The Observed	Observers 1	Observers 2	Average
1	Greetings and start learning by praying	4	4	4
2	Presence of student attendance and Convey the intent and purpose of learning	4	4	4
3	Provide a stimulus so that students are active in each lesson	3	3	3
4	Provide opportunities for students to ask questions or give opinions	3	4	3,5
5	Provide opportunities for students to conclude or suspect related problems given by the teacher	4	3	3,5
6	Discuss students' conjectures or conclusions together	4	4	4
7	Guiding students in concluding the material that has been studied	4	4	4
8	Provide reflection to students	4	3	3,5
9	Closing the lesson by praying together and greeting	4	4	4
	Total	34	33	33.5
	Average	3.77	3.66	3.72

Based on the table above, the results of observations made by observer 1 obtained a score of 3.77 while for observer 2 a score of 3.66 was obtained. According to table 5 the criteria for

the ability of researchers in learning, the average value is obtained which is at an interval of $3.25 \leq x \leq 4{,}00$, which means that it is in the criteria of very well implemented.

b. Data Analysis The Effect of The Guided Discovery Learning Model on Students' Mathematical Creative Thinking Abilities

The pre-test data obtained during the study were from two classes which were research objects, namely VIII C as the experimental class and VIII B as the control class. Information was obtained that the highest score was obtained in the experimental class, namely 62.5 and the lowest value, namely 31.25 with an average -the average is 43.75, while the highest score in the control class is 62.5 and the lowest is 31.25 with an average of 45.5. After obtaining pre-test data information, the normality test, homogeneity test, and t test were carried out.

The normality test is a procedure used to determine whether the data is normally distributed or not. The normality test uses the Kolmogorov Smirnov formula. Results of data analysis using software *SPSS Version 25.*With the criteria if it is significant (p-value) $< \alpha = 0.05$, it means that the data is not normally distributed and vice versa if (p-value) is $\geq \alpha = 0.05$, it means that the data is normally distributed (Ramadhani, 2021: 197).

Based on the results of the normality test with Kolmogorov Smirnov using software *SPSS Version 25* shows that the samples used from both the experimental class and the control class are normally distributed data with a probability (Sig) greater than the alpha value. With the experimental class sig pretest value of $0.054 > 0.050$ while the control class sig pretest value is $0.088 > 0.050$.

After the samples used in the study from both the experimental class and the control class were normally distributed data with a probability (Sig) greater than the alpha value, then the homogeneity value was sought. The homogeneity test aims to determine the variance (diversity) of data from two or more groups that are homogeneous (same) or heterogeneous (not the same). Results of data analysis using software*SPSS Version 25.* With a significant criterion (p-value) of $< \alpha = 0.05$, it means that the data is not homogeneous or heterogeneous and vice versa if (p-value) is $\geq \alpha = 0.05$, it means that the data is homogeneous (Ramadhani, 2021: 214).

Based on the results of the homogeneity test using the software *SPSS Version 25* shows that the significance value (Sig) Based on Mean is $0.548 > 0.050$, so it can be concluded that the pretest data variance of the experimental class and control class is homogeneous (same).

The T test was carried out after it was known that the data taken was normally distributed. Then, to test the hypothesis in this study using the independent sample t test using software *SPSS Version 25.* This hypothesis test was carried outto find out whether there is an influence from the Guided Discovery Learning learning model on students' mathematical creative thinking abilities.

Based on the results of the independent sample t test using the software *SPSS Version 25* above it can be seen that the value of sig. (2-tailed) $0.555 > 0.05$, then H_0 accepted and H_1 rejected. This shows that the scores of the experimental class and the control class are not significantly different. can mean that $H_1 : \mu_1 = \mu_2$ conventional learning models (lectures) have no effect on the ability to think creatively mathematically in class VIII students.

The post-test data obtained during the study were from two classes which were the object of research, namely VIII C as the experimental class and VIII B as the control class.

Information was obtained that the highest score in the experimental class was 93.75 and the lowest score was 68.75 with an average of 81.25, while the highest score in the control class was 81.25 and the lowest was 37.5 with an average of 62.5.

The normality test is a procedure used to determine whether the data is normally distributed or not. The normality test uses the Kolmogorov Smirnov formula. Results of data analysis using software *SPSS Version 25.* With the criteria if it is significant (p-value) $< \alpha = 0.05$, it means that the data is not normally distributed and vice versa if (p-value) is $\geq \alpha = 0.05$, it means that the data is normally distributed (Ramadhani, 2021: 197).

Based on the results of the normality test with Kolmogorov Smirnov using software *SPSS Version 25* shows that the samples used from both the experimental class and the control class are normally distributed data with a probability (Sig) greater than the alpha value. With the experimental class sig pretest value of $0.083 > 0.050$ while the control class sig pretest value is $0.064 > 0.050$.

After the samples used in the study from both the experimental class and the control class were normally distributed data with a probability (Sig) greater than the alpha value, then the homogeneity value was sought. The homogeneity test aims to determine the variance (diversity) of data from two or more groups that are homogeneous (same) or heterogeneous (not the same). Results of data analysis using software *SPSS Version 25.* With a significant criterion (p-value) of $< \alpha = 0.05$, it means that the data is not homogeneous or heterogeneous and vice versa if (p-value) is $\geq \alpha = 0.05$, it means that the data is homogeneous (Ramadhani, 2021: 214).

Based on the results of the homogeneity test using the software *SPSS Version 25* shows that the significance value (Sig) Based on Mean is $0.001 < 0.050$, so it can be concluded that the variance of the post-test data for the experimental class and the control class is not homogeneous (not the same).

The T test was carried out after it was known that the data taken was normally distributed. Then, to test the hypothesis in this study using the independent sample t test using software *SPSS Version 25.* This hypothesis test was carried outto find out whether there is an influence from the Guided Discovery Learning learning model on students' mathematical creative thinking abilities.

Based on the results of the independent sample t test using the software *SPSS Version 25*above it can be seen that the value of sig. (2-tailed) $0.000 < 0.05$, then H_0 rejected and H_1 accepted. This shows that the scores of the experimental class and the control class are significantly different. can mean that $H_1 : \mu_1 \neq \mu_2$ the Guided Discovery Learning learning model influences the ability to think creatively mathematically in class VIII students.

2. Discussion of Research Results

This research was conducted to find out whether or not there was an influence or not from the application of the guided discovery learning model to the mathematical creative thinking abilities of class VIII students at MTs Ma'arif NU 04 Tamansari. In conducting research using two classes as research samples. Then the classes were taken according to the sampling technique, namely the Convenience Sampling technique, and the results obtained were VIII C class as the experimental class and VIII B class as the control class.

In this case, different treatment will be given between the experimental class and the

control class. The experimental class will be given treatment using the guided discovery learning model and the control class will use the lecture method. The material taught at MTs Ma'arif NU 04 Tamansari is material in the even semester, namely statistics. The thing that was examined in this study was the ability to think creatively in mathematics.

Based on the results of the research that has been done, it is known that the experimental class consisted of 24 students with the highest pretest score of 62.5 and the lowest 31.25 with an average of 43.75. Meanwhile, the control class consisted of 22 students with the highest pretest score of 62.5 and the lowest 31.25 with an average of 45.5. From the results of the pretest of the two classes, we can see that the difference in the average scores of the experimental class and the control class is not very significant. So that the students' mathematical creative thinking abilities of the two classes were not too different before being given treatment.

After being given the treatment, a posttest is then given to find out the results of the treatment that has been given. From the results of the posttest, it was found that class VIII C as the experimental class got the highest score of 93.75 and the lowest score of 68.75 with an average of 81.25. Whereas in class VIII B which is the control class, the highest score is 81.25 and the lowest score is 37.5 with an average of 62.5. From these results it is known that there is a significant difference from the results of the posttest.

After the research has been carried out and the results have been obtained, a hypothesis test will be carried out. In this case, the hypothesis test was carried out using an independent sample t test. Prior to that, normality and homogeneity tests were carried out on the pretest and posttest data from the experimental class and the control class. From the results of data analysis normally distributed with (p-value) $\geq \alpha$ = 0.05, namely the sig pretest value of the experimental class was $0.054 > 0.050$, the sig posttest value of the experimental class was $0.083 > 0.050$, the sig pretest value of the control class was $0.088 > 0.050$, and the sig posttest value of the control class was $0.064 > 0.050$. And the pretest data is homogeneous with a significance value (Sig) Based on Mean is $0.548 > 0.050$ while the posttest data is not homogeneous with a significance value (Sig) Based on Mean is $0.001 < 0.050$.

Furthermore, the t independent sample test was carried out to test the hypothesis by comparing the average values of the experimental class and the normally distributed control class. From the results of the t independent sample test using the software*SPSS Version 25*on the pretest it was found that the sig.(2-tailed) value was 0.555 which means it was greater than 0.05 so it was H_0 accepted and H_1 rejected. So it can be concluded that the scores of the experimental class and the control class did not differ significantly, it can be interpreted that the conventional learning model (lecture) has no effect on the ability to think creatively mathematically in class VIII students while the results of the t independent sample test use software *SPSS Version 25*on the posttest it was found that the sig.(2-tailed) value was 0.000, which means it was smaller than 0.05 so it was H_0 rejected and H_1 accepted. So it can be concluded that there is a significant difference in the scores of the experimental class and the control class, it can be interpreted that the Guided Discovery Learning learning model influences the ability to think creatively mathematically in class VIII students.

In this research learning model *Guided Discovery Learning* influence on students' mathematical creative thinking abilities, this is supported by research conducted by research

conducted by Ekawati in 2020 Faculty of Teacher Training and Education, University of Muhammadiyah Makassar entitled "Application of the Guided Discovery Learning Model on Physics Learning Outcomes of Class X MIPA Students of SMA Negeri 9 Enkarang". The results of this study are that there is an increase in students' physics learning outcomes after being taught by applying the guided discovery learning model with an N-Gain of 0.55 (moderate criterion). In another study conducted by Amanda Pasca Rini, et al in 2021 entitled "The Guided Discovery Learning Model, Is it Effective in Improving Students' Critical Thinking Ability?". The results of this study are that the guided discovery learning model is effectively applied to students because it can improve students' critical thinking skills. Besides that, thesis by Qorri'ah in 2011 Faculty of Tarbiyah and Teacher Training Sciences UIN Syarif Hidayatullah Jakarta entitled "Use of the Guided Discovery Learning Method to Improve Students' Conceptual Understanding of the Subject of Constructing Curved Sided Spaces". The result of this study is that increasing students' understanding of mathematical concepts using the guided discovery learning method is better than increasing students' understanding of mathematics using conventional methods (lecturing method) on the subject of curved side shapes.

D. Conclusion

Based on the research that has been done, it can be concluded that the influence of apllying Guided Discovery Learning model is carried out very well in the experimental class on statistics material and the Guided Discovery Learning model influences the ability to think creatively mathematically in class VIII students by interpreting the pretest and postest's scores analyzed.

Reference

Andiyana, MA, et al. (2018). Analysis of Middle School Students' Mathematical Creative Thinking Ability on Building Spatial Materials. *Journal of Innovative Mathematics Learning*. Vol. 1 No. 3

Ekawati. (2020). Application of the Guided Discovery Learning Model to the Physics Learning Outcomes of Class X MIPA Students of SMA Negeri 9 Enrekang. Thesis : (Makassar : University of Muhammadiyah Makassar)

Heriyanto, et al. (2020). Analysis of Creative Thinking Ability of Junior High School Students. *PRISMA*. Vol. 3

Putri, KK, et al. (2020). Analysis of Students' Mathematical Creative Thinking Ability in Building Spatial Material. *Proceedings of the National Seminar on Mathematics Education*. Vol.2

Mandasari, L. (2016). Improving High School Students' Mathematical Creative Thinking Skills Through Problem Based Learning Using Autograph Software. *As-Salam Journal*. Vol. 1 No. 1

Marliani, N. (2015). Improving Students' Mathematical Creative Thinking Skills Through the Missouri Mathematics Profect (MMP) Learning Model. *Formative Journal*. Vol. 5 No. 1

Maya, Y. (2019). Application of the Guided Discovery Learning (GDL) Learning Model to Improve Learning Outcomes in SMP NB1 Bandar Baru Students. Thesis: (Banda Aceh : Ar-Raniry State Islamic University Banda Aceh)

Nuha, MA et al. (2018). Mathematical Creative Process wallas Model in Students Problem Posing with lesson Study Approach. *International Journal of Instruction.* Vol. 11 No.2

Hanief, YN and Wasis Himawanto. (2017). Education Statistics. Yogyakarta : Deepublish (CV Budi Utama)

Rini, AA, et al. (2021). Guided Discovery Learning Learning Model, Is it Effective in Improving Students' Critical Thinking Ability?. *Journal of Educational Sciences*. Vol. 3 No. 5

Yusniawati, RP, et al. (2015). Development and Implementation of the Guided Discovery Learning Model combined with Numbered Head Together on the Material of Plant Structure and Its Utilization in Technology at SMP N 4 Karanganyar. *Inquiry Journal*. Vol. 4. No. 4

Qori'ah. (2011). The Use of the Guided Discovery Learning Method to Improve Students' Conceptual Understanding of the Subject of Constructing Curved Sides. Thesis : (Jakarta : Syarif Hidayatullah State Islamic University Jakarta)

Ramadhani, R and Nuraini Sri Bina (2021). Educational Research Statistics Analysis of Mathematical Calculations and SPSS Applications. Jakarta: (Kencana)

Sari, DR, et al. (2019). Analysis of Students' Creative Thinking Ability in View of Student Motivation on Circle Material at Singkawang 12 Public Middle School. *Journal Of Educational Review And Research*. Vol. 2 No.1

Riyanti, M. (2018). Application of the Guided Discovery Learning Model in Increasing Student Learning Participation at SMK N 3 Pontianak. Thesis : (Pontianak : University of Tanjungpura Pontianak)

Sugiyono. (2019). Quantitative Qualitative Research Methods and R & D. Bandung: Alfabeta

Wibowo, T. (2019). Guided Discovery Method Concepts and Applications in MI/SD Science Learning. *Elementary*. Vol. 7 No. 1

Utami, RW, et al. (2020). Improving Students' Mathematical Creative Thinking Skills Through an Open-Ended Approach. *Journal of Educational Sciences.* Vol. 7 No. 1

This page has been intentionally left blank.

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 25-36
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

The Influence of the Student Team Achievement Divisions Model Assisted by GeoGebra Media on the Ability to Comprehend Mathematical Concepts

Desya Adella Nur Afinda [1]✉

[1]*Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto, Purwokerto, Indonesia*
[2]*Universitas Muhammadiyah Purwokerto, Purwokerto, Indonesia*

✉ *Corresponding email: 1917407051@mhs.uinsaizu.ac.id*

Received June 7, 2023
Accepted June 28, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8540

Abstract: This research was conducted based on the low ability to understand mathematical concepts of students in class VIII SMP Muhammadiyah 1 Purwokerto. One of the contributing factors is the use of inappropriate learning models. The solution that is considered capable of increasing the ability to understand mathematical concepts is to apply the STAD learning model assisted by Geogebra media in the learning process. This study aims to find out how the implementation of the application of the STAD model assisted by GeoGebra media and to find out whether there is an influence of the STAD model assisted by GeoGebra media on the ability to understand mathematical concepts in class VIII students of SMP Muhammadiyah 1 Purwokerto. The type of research used is quantitative with experimental research methods. The population in this study were all students of class VIII SMP Muhammadiyah 1 Purwokerto, totaling 118 students, with a sample of 38 students, 24 students from class VIII B and 14 students from class VIII D. The research variable was the STAD model assisted by GeoGebra media as an independent variable and the ability to understand mathematical concepts as the dependent variable. Methods of data collection are done by observation and tests. Data analysis used the T-test, with prerequisite tests for normality and homogeneity tests. The results showed that there was an influence between the STAD model assisted by GeoGebra media on students' ability to understand mathematical concepts.

Keywords: The ability to understand mathematical concepts; STAD models; GeoGebra media.

A. Introduction

Education is a right for every citizen in Indonesia. Education plays an important role for human life and future. This is regulated in the 1945 Constitution article 31 which states that every citizen has the right to obtain basic education and the government seeks and organizes a national education system (UUD, 1945). According to Law No. 20 of 2003, national education has the goal of creating a learning atmosphere and learning process so that students actively develop their potential through spiritual strength, religion, self-control, personality, intelligence, noble character, and the skills needed by them. society, nation and state (Depdiknas, 2003)). To achieve these national education goals, it is necessary to have learning in various fields of study in every school in Indonesia, one of the fields of study that needs to be studied is mathematics.

Mathematics is one of the scientific disciplines that plays a major role and is useful for the development of science and solving problems in everyday life. Although not all of these

problems are mathematical problems, mathematics plays an important role in solving problems. In addition, mathematics is also one of the main subjects at every level of education (Kamarullah, 2017). Thus, mastery of mathematics is needed at every level of education, one of which is secondary education. Considering that learning mathematics is very important for education and survival, every student from an early to middle age should be able to master mathematics.

According to Permendiknas No. 22 of 2006, learning mathematics aims to enable students to have the ability to understand mathematical concepts, explain the interrelationships between concepts and apply concepts or algorithms in a flexible, accurate, efficient and precise way in solving problems (BSNP, 2006). In addition, the objectives of learning mathematics were also stated in the Ministry of National Education in 2003, which aims to make students have the ability to understand mathematical concepts, reasoning, problem solving, mathematical communication with tables, symbols, diagrams and others, and have an attitude of respect for the application of mathematics in everyday life (Depdiknas, 2003). From this explanation to achieve the goals of learning mathematics, students must master several abilities, one of which is the ability to understand mathematical concepts.

Conceptual understanding is a basic ability that is very important for students to have. The importance of understanding concepts is stated by Santrock in Hendriana's book (2021) which says that understanding concepts is an important factor in the learning process. In understanding concepts students not only memorize the concepts they have learned, but are also able to re-express them in their own language or other easy-to-understand forms, provide interpretation of data and are able to apply concepts in various problem solving (Sanjaya, 2009). The importance of students' ability to re-express concepts in their own language, provide interpretation of data, and apply concepts in problem solving is so that students can build a deeper and more meaningful understanding. This is in line with Winarno's opinion stated in Hendriana's book (2021), which says that the ability to understand concepts is an ability that must be considered in the learning process, especially to acquire meaningful mathematical knowledge.

Mathematical concepts according to Dahar (2011) are likened to developmental stones in thinking, meaning that students will experience difficulties in undergoing the learning process to a higher level if they do not understand the concept. Mathematical concepts have relationships with other mathematical concepts, so that if students do not understand the basic concepts, students will have difficulty understanding and solving more complex mathematical problems. By understanding the concepts in depth, students can understand the relationship between these concepts and relate them to the knowledge they already have. This will help students understand more complex material. Apart from that, understanding concepts also helps students to develop other mathematical abilities (Hendriana et al., 2021). Therefore in learning mathematics, conceptual understanding needs to be emphasized, students must understand the basic concepts well before proceeding to more complex concepts. With a good understanding of the concept will help students in solving mathematical problems and problems in everyday life.

According to NCTM (2000), students' understanding of mathematical concepts can be seen from students' ability to: (1) define concepts verbally and in writing; (2) make examples and non-examples; (3) representing concepts with symbols; (4) change the form of

representation to other forms; (5) get to know the various meanings and interpretations of concepts; (6) identify the nature of the concept and the terms that define the concept; (7) distinguish and compare concepts.

But in reality, the current understanding of mathematical concepts is still weak, in fact many students are still wrong when understanding mathematical concepts. This can be proven by the results of the 2018 Program for International Student Assessment (PISA) survey which stated that Indonesia ranks 72 out of 78 countries participating in the survey. The average score obtained by Indonesian students is 379, below the average score of students in other countries, namely 489 (Tohir, 2019). This shows that the ability to understand concepts in Indonesia is still relatively low.

Low understanding of mathematical concepts also occurs at SMP Muhammadiyah 1 Purwokerto. Based on the results of interviews and observations conducted by researchers during the implementation of Field Experience Practice in March 2023, it can be seen that there are still many students who only memorize the formulas that have been given by the teacher, so that when students are given questions that are different from examples, they will have difficulty solving them. this matter. Likewise, when students were given story questions, most of them had difficulty writing them back into mathematical language. Then when the teacher appoints students to re-explain the material they have learned, students cannot explain without looking from the notebook they have written. In addition, when the teacher gave students the opportunity to ask questions, none of the students asked, even though many of them did not understand the material.

There are several factors that cause the low ability of understanding students' mathematical concepts. Based on research conducted by Widyastuti (2015) one of the factors causing the low ability to understand students' mathematical concepts is the learning process which is still teacher-centered. In fact, in the learning process, teachers still use conventional models or lectures, which make the teacher the center of information, so that students tend to be passive in the learning process. To improve the ability to understand mathematical concepts, teachers must apply innovative learning models, so that students are more active during the learning process. One learning model that can facilitate students to be active is the Student Team Achievement Divisions (STAD) learning model.

The Student Team Achievement Divisions (STAD) model is a type of cooperative learning model developed by Robert Slavin and his friends at Hopkin University (Nurdyansyah & Fahyuni, 2016). In the Student Team Achievement Divisions (STAD) model, students will be divided into several heterogeneous groups based on their academic ability to discuss and work together to solve a problem. When studying with groups, students are encouraged to help explain to their friends, so that all members in each group can understand the concept being studied. Then after studying with groups, each student will be tested through quizzes or tests, at which time they are not allowed to work together.

Discussion or group learning, according to the syntax, is carried out to support the Student Team Achievement Divisions (STAD) model. In addition, to improve students' understanding of mathematical concepts, it is necessary to apply learning media in the learning process. According to Azhar (2011), learning media is media that can facilitate the delivery of material to students so that it can be well received and attract students' interest in learning. The use of interactive and interesting learning media will make students more motivated to learn

and actively participate in the learning process. One of the media that can make it easier for students to understand mathematical concepts is geogebra media.

Geogebra is one of the computer-based learning media that can support mathematics learning. Geogebra was created by Markus Hohenwarter in 2001, geogebra was developed to solve mathematical problems, especially regarding geometry and algebra or algebra (Priatna & Arsani, 2019). According to Syahbana (2016), geogebra is a computer program that is used as a tool for constructing and visualizing or demonstrating mathematical concepts interactively and dynamically. GeoGebra provides tools for constructing points, lines, plane shapes, geometric shapes and other geometries accompanied by geometric calculations. Through geogebra abstract mathematical concepts can be visualized so students can more easily understand mathematical concepts.

Based on the description above, this research is important to do, this is in line with the importance of the ability to understand mathematical concepts in learning mathematics. In order to facilitate and improve students' abilities to understand mathematical concepts, teachers must apply innovative learning models and media, so that students are more active during the learning process. One of the learning models and media that is considered suitable for facilitating and increasing the ability to understand concepts is the Student Team Achievement Divisions (STAD) learning model assisted by GeoGebra media. From this, the researcher wants to conduct a study related to the effect of the STAD learning model assisted by GeoGebra media on the ability to understand students' mathematical concepts which the researcher wrote in the title, "The Influence of the Student Team Achviement Divisions Model Assisted by Geogebra Media on the Ability to Comprehend Mathematical Concepts".

B. Methods

The type of research used in this research is quantitative research. The research design used in this study is an experimental research design. Experimental research is research conducted to test hypotheses about a causal relationship between two or more variables. In experimental research, researchers carry out treatments by creating certain conditions by controlling or manipulating one or more independent variables to see their impact on the dependent variable (Kountur, 2009). In this study, the independent variable is "Student Team Achievement Divisions (STAD) Learning Model assisted by Geogebra Media" and the dependent variable is "Students' Ability to Understand Mathematical Concepts".

This research was conducted at SMP Muhammadiyah 1 Purwokerto which is located on Jl. Independence Pioneer No. 6, Penisian, Purwokerto Kulon, Kec. Purwokerto Sel., Banyumas Regency, Central Java. This research was carried out in the 2022/2023 academic year in semester II or even semester, to be exact in May 2023 until completion. The population in this study were all grade VIII students of SMP Muhammadiyah 1 Purwokerto for the 2022/2023 academic year, which consisted of 5 classes, namely classes VIII A, VIII B, VIII C, VIII D, and VIII E with a total of 118 students. The sample is part of the population to be studied. Sampling in this study used a convenience sampling technique, namely researchers chose samples because they were willing and available to be studied (Creswell, 2012). From five classes with a total of 118 students, the researchers took 38 students to serve as research

samples, 24 students came from class VIII B and 14 students came from class VIII D. Class VIII B became the experimental class and class VIII D became the control class.

In this study data collection was carried out by observing and testing. Observations were made to observe the implementation of the STAD learning model assisted by geogebra media, the instrument used to observe the implementation was an observation sheet carried out by two observers. A description test is a test whose questions require a description answer, where the answer is an opinion from the knowledge possessed by an individual (Asrul et al., 2014). In this study, the researcher collected data by means of a description test, namely the pretest and posttest. The pretest was given before the research was conducted while the posttest was given after the research was carried out.

Furthermore, the data analysis method, to find out the implementation of the STAD learning model assisted by geogebra media from the observation sheet, then the decision-making guidelines are as follows:

Table 1. Guidelines for Making Implementation Decisions

Average Score	Description Implementation
$3{,}25 \leq x \leq 4{,}00$	Very good
$2{,}50 \leq x < 3{,}25$	Good
$1{,}75 \leq x < 2{,}50$	Good Enough
$1{,}00 \leq x < 1{,}75$	Not Good

Then to find out whether or not there is an influence of the media-assisted STAD learning model on the ability to understand geogebra's mathematical concepts, it is done by testing the average difference in increasing the ability to understand mathematical concepts using the geogebra media-assisted STAD learning model. To test these differences using pretest and posttest data in the control class and experimental class which were then analyzed by the T test with a significance level of 0.05. The T test was carried out with the help of the SPSS application, before carrying out the T test the prerequisite tests that must be fulfilled, namely the normality test and homogeneity test. Test criteria in the T test, if the significance value (2-tailed) <0.05 then H_0 is rejected and H_1 is accepted. If the significance value (2-tailed) > 0.05 then H_0 is accepted and H_1 is rejected. The hypothesis is as follows:

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

C. Results and Discussion

1. Data Analysis On The Implementation Of The STAD Learning Model Assisted By Geogebra Media

Based on the implementation data taken from the observation sheet given to the observers. Decision making for implementation data analysis follows in table 1. Following are the results of implementation observations filled in by the observer:

Table 2. Implementation Observation Results

No.	Observer	Date of Observation	Score Total	Observer Score	Average Observer Score
1	Wiji Satrianingrum, S.Pd.	Tuesday, May 16 2023	40	3.33	3,42
2	Sisfi Sulistiani, S.Pd.	Tuesday, May 16 2023	42	3.50	
3	Wiji Satrianingrum, S.Pd.	Monday, 22 May 2023	45	3.75	3,84
4	Sisfi Sulistiani, S.Pd.	Monday, 22 May 2023	47	3.92	
Observation Score Results					3,63

Based on table 2, it can be seen that the total average score obtained from the results of implementation observations by Wiji Satrianingrum, S.Pd. and Sisfi Sulistiani is 3.63. Based on the decision-making guidelines in table 1, the value of 3.63 is included in the "Very Good" category. Thus, it can be said that the implementation of the Geogebra-assisted Student Team Achievement Divisions (STAD) learning model in the experimental class is very good.

2. Data Analysis of the Influence of the Student Team Achievement Divisions (STAD) Learning Model Assisted by Geogebra Media on the Ability to Understand Mathematical Concepts

In the influence data analysis, the results from the pretest and posttest from the experimental class and the control class were used, along with the explanation:

a. Experimental Class and Control Class Pretest Data

Pretest data on the ability to understand mathematical concepts in the experimental class and control class were obtained before the application of the Student Team Achievement Divisions (STAD) learning model assisted by GeoGebra media and conventional learning models. The results of the pretest data in the experimental class and control class are presented in the following table:

Table 3. Pretest Value Data for Experiment Class and Control Class

No.	Experimental Class	*Pretest*	Control Class	*Pretest*
1	A H P	64	A H A	75
2	A W U	46	A A P	71
3	A N W	43	A A M	71
4	D D K	71	B K	61
5	D P	75	D A Z	71
6	D R A	75	D K S	61
7	E V P	54	E D T	61
8	F S M	54	E B H	54
9	F S M	39	F A R	68
10	J B A	57	M F K	83
11	K A D	86	M N A	75
12	K S S	64	N F	43
13	M M P	86	S P R	50
14	M F T	79	V D H	43
15	N D A	75		
16	N A R	82		
17	N K	39		
18	P A R	61		
19	R J P	54		
20	R T W	79		

21	S D	46		
22	S L	43		
23	T S K	79		
24	Z A P	61		
	Amount	1512	Amount	887
	Average	63	Average	63.35714

Based on table 3, it can be seen that the pretest score of the experimental class has the lowest score of 30 and the highest score of 86, with an average score of 63 out of 24 students working on it. Meanwhile, the control class had the lowest score of 43 and the highest score of 83, with an average score of 63,35 out of 14 students who worked on it. The difference in the mean scores of the experimental class and the control class was not much different, namely 0.35, which means that the initial abilities of the students from the two classes were the same. This can be proven further by testing the hypothesis of the pretest data. In this study, the hypothesis test used was the t-test with the prerequisite test being the normality test and homogeneity test.

Then the normality test, the normality test is carried out to find out whether the sample comes from a normally distributed population or not. In this study the normality test used the Kolmogorov Smirnov test with the SPSS version 25 application. The decision-making criterion in the test was that the Kolmogorov Smirnov test significance number Sig. ≥ 0.05 then the data is normally distributed and if the significance number is the Shapiro Wilk test Sig. <0.05 which means the data is not normally distributed (Sugiyono, 2015). The following are the results of the pretest value data normality test:

Table 4. Pretest Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest	.131	38	.097	.945	38	.063

a. Lilliefors Significance Correction

Based on table 4, it can be seen that the significance value in the pretest results is greater than 0.05, i.e. 0.063 > 0.05, meaning that H_0 is rejected and H_1 is accepted, so that it can be said that the pretest results data from the experimental class and the control class are normally distributed data..

After the data is tested for normality, it is followed by a homogeneity test, a homogeneity test is carried out to find out whether the samples come from populations that have the same variance. Homogeneity test can be done if the data group is normally distributed. The decision making criterion in the test is if the significance score for the test is homogeneous ≥ 0.05 which means the data is homogeneous and if the significance score for the test is homogeneous < 0.05 which means the data is not homogeneous (Nuryadi et al., 2017). In this study the homogeneity test was carried out using the SPSS version 25 application. Following are the results of the homogeneity test from the pretest value data:

Table 5. Pretest Homogeneity Test Results

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
hasil pretest	Based on Mean	1.754	1	36	.194
	Based on Median	1.731	1	36	.197
	Based on Median and with adjusted df	1.731	1	35.485	.197
	Based on trimmed mean	1.754	1	36	.194

Based on table 5, it can be seen that the data based on the pretest results on the mean has a significance value of 0.194 which is more than 0.05. So that it can be said that the pretest result data is homogeneous data.

The T-test was carried out after it was found that the research data were normally distributed and homogeneous. To test the hypothesis in this study used the T test. In this study the T test was conducted to determine the students' initial ability to understand mathematical concepts. Following are the results of the t test using the SPSS version 25 application:

Table 6. Pretest Data T Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
pretest	Equal variances assumed	1.754	.194	-.074	36	.942	-.35714	4.84340	-10.18001	9.46572
	Equal variances not assumed			-.078	32.449	.938	-.35714	4.55689	-9.63419	8.91991

Based on table 6, from the t-test that has been done it can be seen that the significance value obtained in the pretest data is 0.942. Significance value 0.942 > 0.05, then H_0 is accepted and H_1 is rejected, $H_0 : \mu_1 = \mu_2$, which means that the results of the values of the experimental class and the control class are not significantly different. Thus, it can be said that students' initial abilities regarding understanding mathematical concepts, both from the experimental class and the control class, have the same abilities. So that the geogebra-assisted STAD learning model can be applied to a class known as the experimental class, namely class VIII B and the conventional learning model is applied to the control class, namely class VIII D.

b. Experimental Class and Control Class Posttest Data

Posttest data on the ability to understand mathematical concepts in the experimental class and control class were obtained after the application of the Student Team Achievement Divisions (STAD) learning model assisted by GeoGebra media and conventional learning models. The results of the posttest data in the experimental class and control class are presented in the following table:

Table 7. Posttest value data for experimental class and control class

No.	Experimental Class	*Postest*	Control Class	*Posttest*
1	A H P	80	A H A	77
2	A W U	83	A A P	43
3	A N W	80	A A M	70
4	D D K	90	B K	47
5	D P	93	D A Z	67
6	D R A	90	D K S	77
7	E V P	77	E D T	93
8	F S M	80	E B H	80
9	F S M	90	F A R	60
10	J B A	60	M F K	67
11	K A D	93	M N A	67
12	K S S	97	N F	90
13	M M P	87	S P R	73
14	M F T	87	V D H	60
15	N D A	97		
16	N A R	93		
17	N K	93		
18	P A R	50		
19	R J P	83		
20	R T W	70		
21	S D	100		
22	S L	73		
23	T S K	70		
24	Z A P	100		
	Amount	2016	Amount	971
	Average	84	Average	69.3571

Based on table 7, it can be seen that the posttest scores of the two classes are different. The experimental class had the lowest score of 50 and the highest score of 100, with an average score of 84 out of 24 students working on it. Meanwhile, the control class had the lowest score of 43 and the highest score of 93, with an average score of 69.35 out of 14 students who worked on it. The difference in the average scores of the experimental class and the control class has a significant difference, which is 14.65, which means that the ability to understand mathematical concepts of the two classes is different after being given treatment, the experimental class has a higher average value than the control class. This can be proven further by testing the posttest data hypothesis. In this study, the hypothesis test used was the t-test with the prerequisite test being the normality test and homogeneity test.

Then the normality test, the normality test is carried out to find out whether the sample comes from a normally distributed population or not. In this study the normality test used the Kolmogorov Smirnov test with the SPSS version 25 application. The decision-making criterion in the test was that the Kolmogorov Smirnov test significance number Sig. ≥ 0.05 then the data is normally distributed and if the significance number is the Shapiro Wilk test Sig. <0.05 which means the data is not normally distributed (Sugiyono, 2015). The following are the results of the posttest value data normality test:

Table 8. Posttest Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
hasil_posttest	.121	38	.177	.947	38	.070

a. Lilliefors Significance Correction

Based on table 8, it can be seen that the significance value in the posttest results is greater than 0.05, namely 0.07 > 0.05, meaning that H_0 is rejected and H_1 is accepted. So that it can be said that the posttest result data from the experimental class and the control class are normally distributed data.

After the data is tested for normality, it is followed by a homogeneity test, a homogeneity test is carried out to find out whether the samples come from populations that have the same variance. Homogeneity test can be done if the data group is normally distributed. The decision making criterion in the test is if the significance score for the test is homogeneous ≥ 0.05 which means the data is homogeneous and if the significance score for the test is homogeneous < 0.05 which means the data is not homogeneous. In this study the homogeneity test was carried out using the SPSS version 25 application. Following are the results of the homogeneity test from the posttest value data:

Table 9. Posttest Homogeneity Test Results

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
hasil posttest	Based on Mean	.089	1	36	.768
	Based on Median	.133	1	36	.718
	Based on Median and with adjusted df	.133	1	35.906	.718
	Based on trimmed mean	.104	1	36	.749

Based on table 9, it can be seen that the posttest data based on the mean has a significance value of 0.768 which is more than 0.05. So that it can be said that the posttest result data is homogeneous data.

The t test was carried out after it was known that the existing research data were normally distributed and homogeneous. To test the hypothesis in this study used the T test. In this study the T test was conducted to determine whether the Student Team Achievement Divisions (STAD) learning model assisted by GeoGebra media has a significant effect on students' ability to understand mathematical concepts. Following are the results of the t test using the SPSS application:

Table 10. Posttest Data T Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
posttest	Equal variances assumed	.089	.768	3.302	36	.002	14.64286	4.43436	5.64956	23.63615

	Equal variances not assumed			3.198	24.737	.004	14.64286	4.57938	5.20636	24.07935

Furthermore, based on table 10, from the t test that has been carried out, it can be seen that the significance value obtained in the posttest data is 0.002. A significance value of 0.002 <0.05 means H_0 is rejected and H_1 is accepted, $H_1 : \mu_1 \neq \mu_2$, which means that there are differences in the results of the experimental class using the STAD model assisted by Geogbra media and the control class using the conventional model. Then, if seen from table 4.7, it can be seen that the average value in the experimental class was 84 and the control class was 69.35. This means that the average value in the experimental class is higher than the control class.

From the same initial abilities in the experimental class and control class, after being given treatment, namely the experimental class which was treated using the geogebra-assisted STAD learning model and the control class which was treated using conventional learning models. It can be seen from the results of the posttest or the final results in both classes, namely the experimental class obtained better scores than the control class. Thus it can be said that there is an influence of the Student Team Achievement Divisions (STAD) model assisted by geogebra media on the ability to understand students' mathematical concepts in class VIII circle material at SMP Muhammadiyah 1 Purwokerto.

From the results of this study, it can be said that the Student Team Achievement Divisions (STAD) learning model assisted by Geogebra media can be a way to improve students' understanding of mathematical concepts. This is in line with the results of research conducted by Pitri Oktaviani, Nurhanurawati, and Coesamin (2013) which stated that the STAD type cooperative learning model had an effect on students' understanding of mathematical concepts and also the results of research conducted by Ramantia (2016) which stated that there was an effect of using geogebra on the ability to understand mathematical concepts.

D. Conclusion

Based on the results of the research that has been done, on the results of observations made by Wiji Satrianingrum, S.Pd. and Sisfi Sulistiani achieved an average score of 3.63. Based on the decision-making guidelines, the value of 3.63 is included in the "Very Good" category, so it can be concluded that the implementation of the Student Team Achievement Divisions (STAD) learning model assisted by GeoGebra media in the experimental class is very good.

The application of the Student Team Achievement Divisions (STAD) model with assisted by geogebra media has an effect on the ability to understand mathematical concepts of class VIII students at SMP Muhammadiyah 1 Purwokerto. This can be proven from the results of hypothesis testing using the t-test, namely a significance value of 0.002 <0.05 is obtained, so H_0 is rejected and H_1 is accepted, which means that there are differences in the ability to understand students' mathematical concepts between the experimental class and the control class. This difference is then seen from the average value obtained by the experimental class that applies the STAD model assisted by geogebra media which is higher than the control class which applies the conventional model.

References

Asrul, Ananda, R., & Rosinta. (2014). Evaluasi Pembajalaran. In *Ciptapustaka Media*.

Azhar, A. (2011). *Media Pembelajaran*. PT Raja Grafindo Persada.

BSNP. (2006). *Permendiknas No.22 Tahun 2006, Tentang Standar Isi Untuk Satuan Pendidikan Dasar dan Menengah*. Depdiknas.

Creswell, J. W. (2012). *Educational Research Planning, Conducting and Evaluating Quantitative and Qualitative Research*. Nebraska.

Dahar, R. W. (2011). *Teori-teori Belajar dan Pembelajaran*. Erlangga.

Depdiknas. (2003). *Undang-Undang Nomor 20 Tahun 2003, Tentang Sistem Pendidikan Nasional*. Depdiknas.

Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2021). *Hard Skills dan Soft Skills Matematik Siswa*. Refika Aditama.

Kamarullah, K. (2017). Pendidikan Matematika Di Sekolah Kita. *Al Khawarizmi: Jurnal Pendidikan Dan Pembelajaran Matematika*, *1*(1), 21. https://doi.org/10.22373/jppm.v1i1.1729

Kountur, R. (2009). *Metode Penelitian Untuk Penyusunan Skripsi Dan Tesis*. Percetakan Buana Printing.

NCTM. (2000). *Principles and Standards for School Mathematics*. The National Council of Teachers of Mathematics.

Nurdyansyah, & Fahyuni, E. F. (2016). Inovasi Model Pembelajaran Sesuai Kurikulum 2013. In *Nizmania Learning Center*.

Nuryadi, Astuti, T. D., Utami, E. S., & Budiantara, M. (2017). *Buku Ajar Dasar-dasar Statistik Penelitian*. Sibuku Media.

Oktaviani, P., Nurhanurawati, & Coesamin, M. (2013). Pengaruh Penerapan Model Pembelajaran Kooperatif Tipe Student Teams Achievement Division Terhadap Pemahaman Konsep Matematis Siswa. *Jurnal Universitas Lampung*, *1*(5), 2–8.

Priatna, N., & Arsani, M. (2019). *Media Pembelajaran Matematika Dengan Geogebra*. Remaja Rosdakarya.

Ramantia, E. (2016). *Pengaruh Penggunaan Geogebra Terhadap Kemampuan Pemahaman Konsep Matematis*. Universitas Lampung.

Sanjaya. (2009). *Strategi Pembelajaran Beorientasi Standar Proses Pendidikan*. Prenada.

Sugiyono. (2015). *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif, dan R&D)*. Alfabeta.

Syahbana, A. (2016). *Belajar Menguasai Ali Syahbana*. https://syahbanaumb.files.wordpress.com/2016/06/buku-geogebra-pdf.pdf

Tohir, M. (2019). Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015. *Paper of Matematohir*, *2*(1), 1–2. https://matematohir.wordpress.com/2019/12/03/hasil-pisa-indonesia-tahun-2018-turun-dibanding-tahun-2015/

UUD. (1945). *Undang-Undang Dasar 1945 pasal 31 ayat 1*. Republik Indonesia.

Widyastuti, E. (2015). Peningkatan Kemampuan Pemahaman Konsep Dan Komunikasi Matematis Siswa Dengan Menggunakan Pembelajaran Kooperatif Jigsaw. *Journal of Mathematics Education*, *1*(1), 3.

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 37-44
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

Influence of Quizizz Aplication As Quantum Learning Model Toward the Concept of Understanding Mathematics Ability

Hilma Arini Millati [1]✉

[1]*Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto, Purwokerto, Indonesia*

✉ *Corresponding email: 1917407081@mhs.uinsaizu.ac.id*

Received June 11, 2023
Accepted June 28, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8605

Abstract: One of the external factors that influenced the concept of understanding ability is the learning style used in classroom activities. The aim of this research is to investigate whether Quizizz application as the Quantum learning model influence or not the concept of understanding ability at grade XI Senior High School NU 1 Kemranjen. The purpose of this study is to find out whether there is any influence and the implementation on the application of the Quantum Learning model assisted by the Quiz application on the ability to understand the concept of class XI SMA Ma'arif Nu 1 Kemranjen. This research used an Experiment as a method and a quantitative approach. The population of this research is all students of grade XI senior high school which consist of 166 students. The class XI IPA consists of 27 students as the control class and XI IPA 2 consists of 28 as the experiment class. The result showed that there was influence and implementation using the Quizizz application as the Quantum Learning model. Meanwhile, the instrument of post-test in the control class and experiment class which used an independent sample test achieved sig = 0,000 < α = 0,05 that revealed different average significance, as a result, there is a significant influence using the Quizizz application as Quantum Learning model in the concept of understanding ability of grade XI senior high school NU Kemranjen.

Keywords: Learning style; Quizizz; Quantum learning.

A. Introduction

Education is an effort for every human being to develop his potential through the learning process. Mathematics is a science knowledge acquired by reasoning. These problems can be solved with various mathematical concepts themselves. Mathematics is also called a structured and organized science, because mathematics starts from elements that are not defined, then elements that are defined by axioms and finally at theorems with various concepts. It is from here that students will gain experience that can improve their understanding of mathematical concepts by applying them. However, there are many students who think that learning mathematics is a complicated and very boring lesson because there is a lack of understanding of the mathematical concepts obtained. This is because there are many formulas that must be memorized and understood. So that the assumption appears that learning mathematics is learning that is difficult, complicated and terrible.

Comprehension is an ability to understand the meaning or concept of a known fact, so as to be able to make a picture, model, give some examples, to explain and re-describe more broadly. A concept is an image or design drawn in the mind. While mathematics is a scientific

discipline that has rules and is organized, where there are low concepts to high concepts that are arranged systematically and hierarchically. Conceptual understanding is a key aspect of learning, besides that the ability to understand mathematics is very supportive of the development of other mathematical abilities. Comprehension is an ability to understand the meaning or concept of a known fact, so as to be able to make a picture, model, give some examples, to explain and re-describe more broadly. A concept is an image or design drawn in the mind.

One of the problems in the process of learning mathematics is the low ability of students to understand the concept of learning mathematics. From the results of the Program survey for International Student Assessment (PISA) 2018 places Indonesia in 74th place (sixth from the bottom). Indonesian students' mathematical abilities got 379 in 73rd position.Observing the problem of students' low ability to understand the concept of learning mathematics, ideas are needed in choosing the right learning model as an innovation in building students' conceptual understanding abilities. The right learning model will create a fun learning atmosphere for students in capturing lessons. Optimal learning and able to achieve the goals of learning.

Based on the results of observations made by means of non-formal interviews with mathematics teachers at SMA Ma'arif NU 1 Kemranjen, it is said that many students are less active during learning, many students cannot re-express a concept, many students find it difficult to classify objects based on their nature according to the concept and many students have not been able to relate a concept to real life. Therefore, it can be concluded that the ability to understand the concepts of class XI SMA Ma'arif Nu 1 Kemranjen is still low. In addition, the learning model used is less attractive or lacks a good response from students so that students' focus on learning is reduced. The learning model used in SMA Ma'arif Nu 1 Kemranjen is a conventional learning model that only uses methods such as lectures and taking notes on the material that has been delivered. Because the teacher often repeats the material presented, in the end the teacher experiences a lack of time in delivering the material.

Based on the problems above, it is necessary to have ideas regarding how to improve students' understanding of mathematical concepts. One of the right ways to overcome this is by implementing a new learning model. The learning model that can be applied to PTM (face-to-face meetings) to overcome students' lack of ability to understand concepts is the Quantum Learning model assisted by the Quizizz application.

The Quantum Learning learning model is tips, instructions, strategies and the entire learning process that can sharpen understanding of memory, and make learning a fun and rewarding process. This learning model is a learning that makes learning comfortable so as to create harmony between students and teachers. In addition, the Quantum Learning learning model has the advantage of being able to increase academic potential (learning achievement) and increase the creative potential that exists within students. While the use of the Quizizz application as a complement to the Quantum Learning learning process is used as a tool that aims to help improve students' understanding of concepts.

The purpose of this study is to find out whether there is an implementation of the Quantum Learning model assisted by the Quizizz application and whether there is an influence of the Quantum Learning model assisted by the Quizizz application on the concept of understanding mathematics in SMA Ma'arif Nu 1 Kemranjen.

B. Methods

Before the test is carried out, there is a validation questionnaire which includes material, language and construction. This validation aims to determine the feasibility level of the instrument used. There are four scores used, namely as follows:

Table1. Expert Validation Instrument Scoring

Average score	Description implementation
$3{,}25 \leq x \leq 4{,}00$	Very good
$2{,}50 \leq x < 3{,}25$	Good
$1{,}75 \leq x < 2{,}50$	Good Enough
$1{,}00 \leq x < 1{,}75$	Not god

The feasibility of the concept understanding instrument used in this study is based on an analysis that has been validated by the validator.

C. Results and Discussion

The following is an explanation of the results of this study:

1. The results of the analysis of the implementation of the quantum learning learning model assisted by the Quizizz application

Table 2. The analysis of the implementation of the quantum learning learning model assisted by the Quizizz application

Research Partition	Sample Location	Jumlah
1. Nur Halifah	Tuesday, May 6 2023	21,5
2. Khilmatul Fuadiyah	Tuesday, May 6 2023	21,15
Average		3,3

Based on the table above, the results of observations made by observer 1 Nur Halifah were 21.5 while for observer 2, namely Khilmatul Fuadiyah, it was 21.15. Based on the table of the researcher's ability criteria, an average value of 3.3 was obtained which was at an interval of $3.25 \leq x \leq 4.00$, which means that the criteria were well implemented.

2. The application of the analysis of the implementation of the quantum learning learning model assisted by the Quizizz application

Following are the results of data analysis:

a. Experimental Class and Control Class Pretest data

The following are the results of the control class pretest and the experimental class

Table 3. Posttest value DataFor Experiment Class and Control Class

Numb.	Name	Pretest	Name	Pretest
1	A.1	25	B.1	3
2	A.2	3	B.2	28
3	A.3	18	B.3	11
4	A.4	28	B.4	14
5	A.5	14	B.5	14
6	A.6	21	B.6	25
7	A.7	14	B.7	21

8	A.8	18	B.8	21
9	A.9	14	B.9	25
10	A.10	11	B.10	32
11	A.11	11	B.11	28
12	A.12	7	B.12	18
13	A.13	21	B.13	25
14	A.14	11	B.14	25
15	A.15	3	B.15	18
16	A.16	25	B.16	7
17	A.17	7	B.17	14
18	A.18	14	B.18	11
19	A.19	7	B.19	14
20	A.20	21	B.20	21
21	A.21	25	B.21	11
22	A.22	28	B.22	18
23	A.23	32	B.23	3
24	A.24	3	B.24	18
25	A.25	18	B.25	3
26	A.26	3	B.26	7
27	A.27	21	B.27	7
28	A.28	18		

The normality test is a prerequisite test regarding the feasibility of data to be analyzed using parametric statistics. This normality test aims to determine whether or not the distribution of pretest results data is normal or not. The results of data analysis using SPSS Version 25 software. The normality test used in this study is the Kolmogorof Smirnov test. Application of the Kolmogorof Smirnov test if the significance (p-value) < α = 0.05 means that the data is not normally distributed. If the significance (p-value) ≥ α = 0.05, it means that the data is normally distributed. The normality test results are as follows:

Tabel 4. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Hasil Belajar	,102	55	,200	,951	55	,026

After the two class data are normally distributed with a value sig.= 0,176 > α = 0,05, then the homogeneity value is sought. Homogeneity test was carried out to find out whether the variance of the data from the samples analyzed was homogeneous or not. In this study, the homogeneity test used the Levenve test. The results of data analysis using SPSS software Version 25. With the criteria if significant (p-value) < α = 0,05 means the data is not homogeneous and vice versa if (p-value) ≥ α = 0,05 means the data is homogeneous. The following is the result of homogeneity:

Tabel 5. Test of Homogeneity of Variance

		Levene Statistic	**df1**	**df2**	**Sig.**
Hasil Belajar	Based on Mean	,005	1	53	,942
	Based on Median	,014	1	53	,906
	Based on Median and with adjusted df	,014	1	52,723	,906
	Based on trimmed mean	,005	1	53	,944

The T test is carried out after it is known that the data taken is normally distributed. The t-test aims to determine the effect of the Quantum Learning model assisted by the Quizizz application on students' understanding of concepts by comparing the average results of the experimental class with the control class. Then to test the hypotheses in this study using an independent sample t test using SPSS Version 25 software. The following is is the result of the -t test:

Tabel 6. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Hasil Belajar	Equal variances assumed	,005	,942	,275	53	,784	,620	2,256	-3,904	5,145
	Equal variances not assumed			,275	52,967	,784	,620	2,255	-3,904	5,144

The decision criterion H_0 is accepted if the sig. $\geq \alpha = 0{,}05$ and H_1 is accepted if the sig. $< \alpha = 0.05$. Based on the results of the independent sample t test using SPSS Version 25 software, it can be seen that the two variances are homogeneous with sig = 0.914 > α = 0.05, so the sig value –t test refers to assumed equal variances. So it is obtained that the significance value is sig = 0.850 > α = 0.05. From the predetermined decision criteria, H_0 is accepted, so there is no average difference in the pretest results. This means that the initial understanding of the concept of the control and experimental classes is the same.

b. Experimental Class and Control Class Posttest data

The following are the results of the control class posttestt and the experimental class:

Table 7. Posttest value DataFor Experiment Class and Control Class

Numb.	Name	Posttest	Name	Posttest
1	A.1	64	B.1	96
2	A.2	96	B.2	82
3	A.3	64	B.3	100
4	A.4	67	B.4	100
5	A.5	82	B.5	100
6	A.6	86	B.6	93
7	A.7	86	B.7	86
8	A.8	75	B.8	93
9	A.9	89	B.9	96
10	A.10	78	B.10	78
11	A.11	78	B.11	86
12	A.12	67	B.12	89
13	A.13	89	B.13	93
14	A.14	96	B.14	89
15	A.15	71	B.15	96
16	A.16	82	B.16	100
17	A.17	71	B.17	89
18	A.18	82	B.18	82

19	A.19	71	B.19	75
20	A.20	57	B.20	93
21	A.21	82	B.21	75
22	A.22	93	B.22	75
23	A.23	100	B.23	93
24	A.24	64	B.24	89
25	A.25	57	B.25	100
26	A.26	53	B.26	86
27	A.27	75	B.27	78
28	A.28	75		

The normality test is a prerequisite test regarding the feasibility of data to be analyzed using parametric statistics. This normality test aims to determine whether or not the distribution of pretest results data is normal or not. The results of data analysis using SPSS Version 25 software. The normality test used in this study is the Kolmogorof Smirnov test. Application of the Kolmogorof Smirnov test if the significance (p-value) < α = 0,05 means that the data is not normally distributed. If the significance (p-value) ≥ α = 0,05, it means that the data is normally distributed. The normality test results are as follows:

Tabel 8. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Hasil Belajar	,107	55	,176	,950	55	,022

After the two class data are normally distributed with a value sig. = 0,176 > α = 0,05 and the value is sig. the experimental class is sig = 0,108 > α = 0,05, then the homogeneity value is sought. Homogeneity test was carried out to find out whether the variance of the data from the samples analyzed was homogeneous or not. In this study, the homogeneity test used the Levenve test. The results of data analysis using SPSS software Version 25. With the criteria if significant (p-value) < α = 0,05 means the data is not homogeneous and vice versa if (p-value) ≥ α = 0,05 means the data is homogeneous. The following is the result of homogeneity:

Tabel 9. Test of Homogeneity of Variance

		Levene Statistic	**df1**	**df2**	**Sig.**
Hasil Belajar	Based on Mean	4,844	1	53	,032
	Based on Median	4,853	1	53	,032
	Based on Median and with adjusted df	4,853	1	46,022	,033
	Based on trimmed mean	4,828	1	53	,032

The T test is carried out after it is known that the data taken is normally distributed. The t-test aims to determine the effect of the Quantum Learning model assisted by the Quizizz application on students' understanding of concepts by comparing the average results of the experimental class with the control class. Then to test the hypotheses in this study using an independent sample t test using SPSS Version 25 software. The following is is the result of the -t test:

Tabel.10 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Hasil Belajar	Equal variances assumed	4,844	,032	4,356	53	,000	12,548	2,881	6,770	18,325
	Equal variances not assumed			4,388	46,930	,000	12,548	2,860	6,795	18,301

The decision criterion H_0 is accepted if the sig. $\geq \alpha = 0,05$ and H_1 is accepted if the sig. $< \alpha = 0,05$. Because the variance is homogeneous with a value of sig = 0,032 $<\alpha = 0,05$, the sig value of the –t test refers to equal variances not assumed. From the table it can be seen that the value of sig. = 0,000 $< \alpha = 0.05$, means that H_1 is accepted and means $\mu 1 \neq \mu 2$. Because the initial abilities of the two classes are the same and the final abilities are different, it can be concluded that there is an influence of the Quantum Learning model assisted by the Quiziz Application on the students' understanding of SMA Ma'arif Nu 1 Kemranjen.

D. Conclusion

Based on the results of the research, it is known that there is an implementation of the Quantum Learning model assisted by the Quizizz application on the conceptual abilities of Ma'arif Nu 1 Kemranjen High School students. It can be seen that the average result of the two observers is 3.3. So that at vulnerable $3.25 \leq x \leq 4$ it can be concluded that there is a very good implementation.

Furthermore, it is known that learning with the Quantum Learning model assisted by the Quizizz application is able to influence the ability to understand the concepts of Ma'arif Nu 1 Kemranjen High School students. This can be seen from the results of the Independent Sample T-Test with a value of sig = 0.000 $<\alpha = 0.05$, means that H_1 is accepted and means $\mu_1 \neq \mu_2$. Because the initial abilities of the two classes are the same and the final abilities are different, it can be concluded that there is an influence of the Quantum Learning model assisted by the Quiziz Application on the students' understanding of SMA Ma'arif Nu 1 Kemranjen.

References

Anisa, R.M. & Putri, D.H. (2019). The Influence of the Quantum Learning Model on Understanding Concepts and Learning Outcomes of Class X Students. *Journal of Coil Physics* 2, no. 3.

Azwa, A.N. (2018). *The Influence of Quantum Learning Methods on Solving Ability Vii Mts Bahrul Ulum Rebang Tangkas Vii Mts Bahrul Ulum Rebang Tangkas*. http://repository.radenintan.ac.id/4216/.

Bobbi, D.P. & Hernacki, M. (2011). *Quantum Learning*.

Hendriana, H. et al. (2017). *Hard Skills And Soft Skills Mathematics Students*. Bandung: PT

Rafika Aditama.

Indrayani, K., Ayu, N.M.A., Pujani, N.L., Devi, P.L. (2019). The Effect of the Quantum Learning Model on Increasing Student Science Learning Outcomes. *Journal of Indonesian Science Education and Learning* (JPPSI) 2, no. 1.

Jay, I. (n.d.). *Research Statistics Book for Education*. Bandung: Cipta Pustaka Media Pioneer.

Joseph, Febrianawati. (2018). Test the Validity and Reliability of Quantitative Research Instruments. *Tarbiyah Journal: Educational Scientific Journal* 7, no. 1.

Maika, A. (2020) The Influence of Using Geogebra Software on Students' Understanding of Mathematical Concepts at Madrasah Tsanawiyah Negeri 5 Jambi City. *International Journal Of Hypertension* 1, no. 1.

Meita, P.N., Sugiyanti, Ariyanto, L. (2021). The Influence of Quantun Learning Models and Active Learning Assisted by the Quiziz Application. *Imaginary: Journal of Mathematics and Mathematics Education* 3, no. 5.

Miftaqulzanah. (2021) *Analysis of Concept Understanding Ability of Grade VII Middle School Students*. UIN Syarif Hidayatullah.

Ministry of National Education. (2006). *Law on National Education*. Jakarta: Sinar Graphics.

Misbahudin, I.H. (2013). *Research Data Analysis With Statistics*. Jakarta: Earth Literature.

Nugroho, S. (2018). Introduction to Mathematical Statistics. UNIB Press.

Pebriana, E., Sari, B.M., Abdurrahman, Y. (2019). Modification of the Quantum Learning Model with Task and Forced Learning Strategies. *Proceedings of the National KALUNI Education Seminar* 2.

Rahmah. (n.d.). *The Nature of Mathematics Education*.

Ridwan, L. (n.d.). *Mathematics Education Research: A Practical Guide to Writing Thesis, Theses and Research Reports Using a Quantitative Qualitative Approach, and Combinations Accompanied by Learning Models and Mathematical Skills*.

Sanga, L. & Purba, L. (n.d.). *Increasing Student Learning Concentration Through Utilization of Quizizz Learning Evaluation in Chemistry Physics I Course*.

Sri, H.N. (2017). *Mathematics Learning Strategy*. Yogyakarta: Mathematics.

Sugiono. (2011). *Educational Research Methods: Quantitative, Qualitative, and R&D Approaches*. Bandung: Alphabet.

Supriadi, Nunung, Tazkiyah, D., Isro, Z. (2021). Application of the Quizizz Application in Online Learning in the Era of Covid-19. *Cakrawala Mandarin Journal* 5, no. 1.

Tersiana, A. (2022). *Research methods*. Edited by Herman Adamson. First. Yogyakarta: Indonesia's Great Children.

Thoha, M. & Ambarita, A. (2016). *Applied Statistics in Education*. Yogyakarta: Media Academy.

Usmadi. (n.d.). Analysis Requirements Tester (homogeneity test and normality test). *Educational Innovation*.

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 45-54
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

The Influence of Flipped Classroom Learning Strategies To Improve the Ability In Understanding Mathematics Concepts

Fenita Riyanti[1]✉, Amel Zitouni[2]

[1]*Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto, Purwokerto, Indonesia*
[2]*Department of Sciences Ecole Normale Supérieure de Sétif, Sétif, Algeria*

✉ *Corresponding email: 1917407081@mhs.uinsaizu.ac.id*

Received June 7, 2023
Accepted June 28, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8546

Abstract: The ability to understand concepts is very important to understand learning material in the framework of learning outcomes that are in line with the goals to be achieved. The low understanding of students is caused by two factors, namely internal factors and external factors. Internal factors are factors inside of the students. While external factors are factors that are coming from outside of the students. The selection of learning strategies is an external factor that can increase students' understanding. Learning methods that are less innovative and boring, such as only listening to teacher explanations and lack of student activity in learning, are still teacher-centered and students often feel bored with the ongoing learning. This type of research uses an experimental method. The population in this study was class VIII at SMP Negeri 1 Baturaden. The sample of this research was class VIII A and VIII B which consisted of 66 students. The data analysis used the T-test. Conceptual understanding is an important aspect of learning that allows students to acquire in-depth and sustainable knowledge. In recent years, the Flipped classroom learning strategy has emerged as an innovative approach in education, in which learning materials are conveyed to students outside the classroom through videos or reading materials, while class time is used for discussion and application of concepts. This study aims to determine the effect of the strategy using flipped classroom.

Keywords: active interaction, conceptual understanding, education Flipped classroom, learning strategy.

A. Introduction

Understanding the concept is the main goal in learning which allows students to build in-depth and sustainable knowledge. However, conventional learning approaches often face obstacles in achieving in-depth understanding. Therefore, innovative learning strategies such as Flipped Classroom have been introduced as an attractive alternative. Flipped Classroom utilizes technology and the role of students in learning, where learning material is conveyed outside the classroom through videos or reading materials, while class time is used for discussion, problem solving, and application of concepts. An important factor in the teaching and learning process is understanding concepts, understanding concepts is one of the most important parts of learning mathematics, because mathematics is not only about calculating or just memorizing formulas, but also understanding the concepts of the material being studied so that you can work on problems more easily. Understanding of concepts is very related to students' interest in learning, understanding concepts is the basic goal of learning mathematics, when students understand mathematical concepts, these students will easily solve problems in mathematics. The ability to understand concepts is very important to understand learning

material in the framework of learning outcomes that are in accordance with the goals to be achieved. At present many teachers teach mathematics only by presenting material in class or we can call it a conventional learning strategy so that students are only able to solve math problems without understanding the solution to the problems given by the teacher. The low understanding of students is caused by two factors, namely internal factors and external factors. Internal factors are factors from within while external factors are factors that are outside the individual. Selection of learning strategies is an external factor that can improve student understanding. This study aims to investigate the effect of Flipped Classroom learning strategies on students' conceptual understanding abilities. In this context, we want to determine whether the application of Flipped Classroom can improve students' understanding of concepts compared to conventional learning approaches.

And the implementation of the flipped classroom learning strategy. From interviews conducted by researchers with one of the Mathematics teachers in Class VIII at SMP Negeri 1 Baturaden, namely Mrs. Yuli Puji Astuti S.Pd., one of the reasons for the low understanding is the ineffective learning strategy, which affects students' understanding to the subject matter, evidenced by the learning strategies that are usually applied by teachers at SMP Negeri 1 Baturaden in the learning process are conventional methods such as lectures, taking notes on the material provided, according to the Mathematics teacher at SMP Negeri 1 Baturaden the learning methods are less innovative and boring as only listening to explanations teachers and lack of student activity in learning, and are still centered on educators and often students feel bored with ongoing learning, therefore appropriate strategies are needed so that learning is more effective. Teachers in learning mathematics in the classroom also still lack a lot of teaching time to make students understand the material presented because the teacher has to repeat it many times so that students understand. Students do not try to work on the example questions given by the teacher, late in submitting assignments, often waiting for answers from the theme, this is what causes students at SMP Negeri 1 Baturaden to be unable to properly solve questions from the material that has been given by the teacher. The flipped classroom learning strategy is one of the learning strategies that can be used to assist students in learning which provides opportunities for students to develop their potential. During the research, the factors that influence the success of Flipped Classroom are also observed. Active interaction between students and teachers, both in the form of class discussions and collaborative activities, has been shown to be a key factor in increasing conceptual understanding. In addition, easy access to learning materials outside the classroom provides students with flexibility. The flipped classroom learning model is a learning model in which students are required to study the subject matter first at home before the material is delivered by the teacher in the classroom, so that when the learning process takes place in the classroom students only discuss issues that are not yet understood and do task The flipped classroom learning model is different from the learning model that is generally used in schools. In this flipped classroom learning model, students can repeat and re-learn at home, at school, anywhere and anytime by using electronic teaching media without having to wait for guidance from educators in understanding the material being taught.

Thus understanding the concept can help students to simplify, summarize, and classify information. By understanding the concept students can simplify, summarize, and classify information. With an understanding of the concept can also improve students' ability to

understand new information that is used to retrieve a knowledge that has been obtained. Concept understanding activities are not always carried out in the classroom, students are able to learn mathematical concepts through daily activities. The low understanding of mathematical concepts is not only caused by the lack of students' ability in mathematics, but there are other factors that can influence it. Understanding of the concept is influenced by several factors, including: internal factors (within the student), and external factors (factors from outside the student).

B. Methods

This study uses an experimental design with two groups, namely the experimental group that applies Flipped Classroom and the control group that follows a conventional learning approach. Research participants consisted of students from the same or similar classes with similar levels of conceptual understanding. Data was collected through conceptual understanding tests before and after the intervention. The research design used in the study was the Pretest and Posttest Control Group. The research was started by giving a pretest to the experimental class and control class, then giving mathematics learning to the experimental class using the flipped classroom learning model and the control class using the lecture method. After carrying out the entire learning series, the two classes were given a posttest with the aim of knowing the increase in students' understanding of mathematical concepts.

The research was conducted at SMP Negeri 1 Baturaden which is located at Jl. Raya Baturaden No. 20, Dusun II, Rempoah, kec. Baturaden, Banyuma Regency, Central Java, postal code 53126 in the even semester of the 2022/2023 school year.

Population and sample. The population is a generalization area consisting of objects/subjects that have certain quantities and characteristics determined by the researcher to be studied and then conclusions drawn. In this study, the population taken was class VIII students of SMP Negeri 1 Baturaden in the academic year 2022/2023, which consisted of 8 classes, namely classes VIII A, VIII B, VIII C, VIII D, VIII E, VIII F, VIII G, and VIII H with a total of 227 students. The sample is part of the population taken by a certain method. In this study, the samples taken were 2 classes (control class and experimental class). Population and sample.

The population is a generalization area consisting of objects/subjects that have certain quantities and characteristics determined by the researcher to be studied and then conclusions drawn. In this study, the population taken was class VIII students of SMP Negeri 1 Baturaden in the academic year 2022/2023, which consisted of 8 classes, namely classes VIII A, VIII B, VIII C, VIII D, VIII E, VIII F, VIII G, and VIII H with a total of 227 students. The sample is part of the population taken by a certain method. In this study, the samples taken were 2 classes (experimental class and control class). The researcher made class VIII A as the control class and class VIII B as the experimental class. Sampling in this study used the Convenience Sampling technique (Desire Sampling). Convenience Sampling technique is a sampling technique by selecting students because they are often easily available.

The expert validation questionnaire includes material suitability, appropriate language, and construction. This validation aims to determine the feasibility level of the instrument. There

are four response options with different scores for each. The following is the expert instrument scoring table, namely:

Table1. Expert Validation Instrument Scoring

Average score	Description implementation
$3{,}25 \leq x \leq 4{,}00$	Very good
$2{,}50 \leq x < 3{,}25$	Good
$1{,}75 \leq x < 2{,}50$	Good Enough
$1{,}00 \leq x < 1{,}75$	Not god

The feasibility of the mathematical creative thinking ability instrument in this study is shown based on the results of the analysis that has been validated by the validator.

C. Results and Discussion

1. Data Analysis Implementation of Flipped Classroom Learning Strategies

The following will explain the result and discussion of this study:

Table 2. Data Analysis Implementation of Flipped Classroom Learning Strategies

Research Partition	Sample Location	Sum
1. Ibu Yuli S.Pd	Tuesday, May 16 2023	26
2.Azkiyah	Tuesday, May 16 2023	27
Average		3,75

Based on the table above, the results of observations made by observer 1, Mrs. Yuli Puji Astuti, was 37.1, while for observer 2, namely Azkiyah, it was 38.5. According to the table of the researcher's ability criteria, an average value of 3.75 is obtained which is at an interval of $3.25 \leq x \leq 4.00$, which means that it is in the criteria of well implemented.

2. The application of flipped classroom learning strategies to learning mathematics

In the influence data analysis, along with the explanation:

a. Experimental Class and Control Class Pretest data

The following is pre-test data obtained during the study, namely from two classes which were the object of research, namely VIII A as the control class and VIII B as the experimental class.

Table 3. Pretest value DataFor Experiment Class and Control Class

No	Eksperimen class	Pretest	Kontrol class	Pretest
1.	A1	54	B1	82
2.	A2	52	B2	82
3.	A3	67	B3	62
4.	A4	68	B4	70
5.	A5	76	B5	82
6.	A6	74	B6	54
7.	A7	56	B7	67
8.	A8	78	B8	67
9.	A9	72	B9	74

10.	A10	68	B10	57
11.	A11	72	B11	50
12.	A12	76	B12	67
13.	A13	71	B13	82
14	A14	68	B14	80
15.	A15	72	B15	78
16.	A16	70	B16	60
17.	A17	72	B17	77
18.	A18	71	B18	58
19.	A19	68	B19	68
20.	A20	80	B20	70
21.	A21	48	B21	62
22.	A22	84	B22	72
23.	A23	64	B23	72
24.	A24	82	B24	62
25.	A25	75	B25	71
26.	A26	58	B26	48
27.	A27	62	B27	62
28.	A28	62	B28	64
29.	A29	60	B29	71
30.	A30	61	B30	72
31.	A31	-	B31	48
32.	A32	-	B32	50
33.		-	B33	62
34.		-	B34	68
35.			B35	64

The normality test is a procedure used to determine whether the data is normally distributed or not. The normality test uses the Kolmogorov Smirnov formula. The results of data analysis using SPSS Version 25 software. With the criteria if it is significant (p-value) < $\alpha = 0.05$, it means that the data is not normally distributed and vice versa if (p-value) $\geq \alpha = 0.05$, it means that the data is normally distributed. The normality test results are as follows

Table 4.Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
KELAS_A	.132	30	.194	.976	30	.699
KELAS_B	.088	30	.200*	.962	30	.344

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

After the samples used in the study from both the experimental class and the control class were normally distributed data with a probability (Sig) greater than the alpha value, then the homogeneity value was sought. The homogeneity test aims to determine the variance (diversity) of data from two or more groups that are homogeneous (same) or heterogeneous (not the same). The results of data analysis using SPSS Version 25 software. With the criteria if it is significant (p-value) < $\alpha = 0.05$, it means that the data is not homogeneous or heterogeneous and vice versa if (p-value) $\geq \alpha = 0.05$, it means that the data is homogeneous. The results of homogeneity are as follows:

Table 5.Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Based on Mean	.184	1	58	.670

hasil *pretest*	Based on Median	.178	1	58	.675
	Based on Median and with adjusted df	.178	1	57.985	.675
	Based on trimmed mean	.183	1	58	.670

The T test was carried out after it was known that the data taken was normally distributed. Then, to test the hypothesis in this study using an independent sample t test using SPSS Version 25 software. This hypothesis test was conducted to determine whether there is an effect of the Flipped Classroom Learning Strategy on the ability to understand mathematical concepts.

Table 6. Pretest Data T

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
HASIL BELAJAR	Equal variances assumed	21.690	.000	-5.793	64	.000	-13.47778	2.32641	-18.12531	-8.83024
	Equal variances not assumed			-5.411	36.277	.000	-13.47778	2.49084	-18.52810	-8.42745

Based on the results of the independent sample t test using the SPSS Version 25 software above, it can be seen that the sig. (2-tailed) 0.000 > 0.05, then H_0 is rejected and H_1 is accepted. This shows that the scores of the experimental class and the control class are significantly different. H_1 : μ_1 > μ_2 can be interpreted that the flipped classroom learning strategy affects the ability to understand mathematical concepts in class VIII students.

b. Experimental Class and Control Class Pretest data

The following is the post-test data obtained during the study, namely from two classes which are the object of research, namely VII A as the control class and VIII B as the experimental class.

Table 7. Postest value Data For Experiment Class and Control Class

No	Eksperimen	Posttest	Kontrol	Post-test
1.	A1	75	B1	96
2.	A2	68	B2	86
3.	A3	57	B3	72
4.	A4	78	B4	84
5.	A5	52	B5	90
6.	A6	50	B6	88
7.	A7	62	B7	84
8.	A8	88	B8	82
9.	A9	80	B9	86
10.	A10	50	B10	88
11.	A11	66	B11	82
12.	A12	61	B12	78
13.	A13	60	B13	94
14	A14	72	B14	82
15.	A15	70	B15	86

16.	A16	74	B16	88
17.	A17	68	B17	82
18.	A18	72	B18	74
19.	A19	50	B19	78
20.	A20	90	B20	80
21.	A21	44	B21	82
22.	A22	88	B22	82
23.	A23	70	B23	80
24.	A24	86	B24	84
25.	A25	82	B25	78
26.	A26	89	B26	84
27.	A27	72	B27	82
28.	A28	74	B28	78
29.	A29	80	B29	82
30.	A30	66	B30	88
31.	A31	-	B31	82
32.	A32	-	B32	82
33.	A33	-	B33	78
34.	A34	-	B34	82
35.	A35	-	B35	90
36.	A36	-	B36	84
	SUM	2094	SUM	2998
	AVERAGE	69,8	AVERAGE	83,2

Based on the table above, information was obtained that the highest score in the experimental class was 96 and the lowest score was 72 with an average of 83.2, while the highest score in the control class was 90 and the lowest was 44.The following is the post-test data obtained during the study, namely from two classes which are the object of research, namely VII A as the control class and VIII B as the experimental class

Table 8.Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
KELAS_A	.132	30	.194	.976	30	.699
KELAS_B	.088	30	.200*	.962	30	.344

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test with the Kolmogorov Smirnov according to the table above, it shows that the samples used from both the experimental class and the control class are normally distributed data with a probability (Sig) greater than the alpha value. With the experimental class sig pretest value of 0.200 > 0.050 while the control class sig pretest value was 0.088 > 0.050.

Table 9. Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
							Std. Error	95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Difference	Lower	Upper
	21.690	.000	-5.793	64	.000	-13.47778	2.32641	-18.12531	-8.83024
			-5.411	36.277	.000	-13.47778	2.49084	-18.52810	-8.42745

The T test was carried out after it was known that the data taken was normally distributed. Then, to test the hypothesis in this study using an independent sample t test using SPSS Version 25 software. This hypothesis test was conducted to determine whether there is an effect of the Flipped Classroom Learning Strategy on the ability to understand mathematical concepts.

D. Conclusion

The Flipped Classroom learning strategy was implemented in the experimental class based on the stages of the Flipped Classroom learning strategy, namely preparation, assessment and evaluation. Through this learning strategy, students can solve math problems, with the material that has been given beforehand before the learning process in class takes place, this allows students to get material beforehand so they can understand statistical material easily. Researchers hope that by implementing this learning strategy, students' understanding of mathematical concepts will further increase.

References

Farida. (2018). The Effect of Heuritic Learning Strategies on the Ability to Understand Mathematical Concepts. *Journal of Mathematics Education*, No.2

Firmansyah, D & Dede. (2022). Common Sampling Techniques in Research Methodology: Literature Review, *Scientific Journal of Holistic Research* (JIPH), Vol. 1, No. 2 , p. 92

Hanif, N.M & Himawanto, W. (n.d.). Education Statistics. Yogyakarta: Deepublish.

Hendriana.H et al. (2017). Hard Skills and Soft Skills Mathematics Students. Bandung: PT Refika Aditama.

John, W.S. (2010). Educational Psychology. Jakarta: Kencana.

Khofifah. L (2020). *Thesis: The Effect of Flipped Classroom Learning Models and Discovery Learning) on Students' Ability to Understand Concepts and Solve Mathematical Problems*. Lampung: UIN Raden Intan Lampung.

Mutmainah, S., Setiawan, Purwanto (2019). Flipped Classroom Learning Model Utilizing Content at Home Learning at the Middle School Level. *Ministry of Education and Culture Center for Information and Communication Technology Education and Culture*.

Nanang, S. (2018). Learning Geogebra-Based Geometry as an Effort to Improve Mathematical Communication Skills of Madrasah Tsanawiyah (Mts) Students. *AlJabar: Journal of Mathematics Education* 6, No. 2.

Netriwati. (2018). Application of the Revised Bloom's Taxonomy to Increase the Ability to Understand Mathematical Concepts. *Decimal: Jurnal Mathematics*, Vol. 1, No. 3.

Nurkholis. (2019). Education In an effort to advance technology. educational journal .vol 1, no.1

Patandean, R. E. & Indrajit, R. E. (2021). *Flipped classroom: makes students think critically, creatively, independently, and be able to collaborate in responsive learning*.

Pebriyanti, N.M. (2020). *Undergraduate thesis: differences in mathematics learning outcomes of students taught flipped classroom and conventional learning strategies*. Makassar: Makassar university.

Riyono, J. (2021). Analysis of factors that influence students' understanding of mathematical concepts, *Journal of mathematics education*, vol.6, No.01.

Rohmad. (2018). *Development of evaluation and research instruments*. Yogyakarta: Mitra Media.

Setiawat, F.A. (2017). *Applied statistics for educational and social research.* Yogyakarta: Parama publishing.

Sudijono, A. (2016). *Introduction to statistics*. Jakarta: PT Raja GrafindoPersada.

Supriadi, N. (2018). Geogebra-Based Geometry Learning as an Effort to Improve Mathematical Communication Skills of Madrasah Tsanawiyah (Mts) Students. *AlJabar: Journal of Mathematics Education* 6, No. 2.

Susanti & Hamama, P. (2019). *Flipped classroom as learning in the digital era*.

Suwarni, D.I (2017) . Breakfast of the Think-Talk-Write learning model and Reciprocal demonstrations to Improve Ecosystem Learning Outcomes for SMP PGRI Suryakencana Bogor Students. *Journal of Scientific Education* Vol. 3, No. 8.

Syamsul, A.E. et al. (2019). Understanding of Mathematical Concepts in the Linear Equation with Two Variables: Impact of E-Learning and Blended Learning Using Google Classroom. *Al-Jabar: Journal of Mathematics Education*, Vol. 10, No. 2.

This page has been intentionally left blank.

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 55-66
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

The Effectiveness of the Problem-Based Learning Model Based on Open-Ended To Improve Mathematical Creative Thinking Skills

Baetul 'Iza [1]✉, Hesti Khasanah[2]

[1]*Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto, Purwokerto, Indonesia*
[2]*Universitas Negeri Yogyakarta, Yogyakarta, Indonesia*

✉ *Corresponding email: 1917407063@mhs.uinsaizu.ac.id*

Received June 8, 2023
Accepted June 28, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8558

Abstract: The ability to think mathematically creative students is very important in mathematics teaching. Students' mathematical creative thinking ability is still relatively low can be seen from various factors. This study aims to find out how the implementation of a Problem-Based learning model based on open-ended to improve students' mathematical creative thinking skills, and to determine the effectiveness of a Problem-Based learning model based on open-ended to improve students' mathematical creative thinking skills. This type of research is quantitative research with experimental methods. The population in this study were all grade VIII MTs N 1 Purbalingga students. The sample of this research was the students of grades VIII G and VIII H with sampling techniques using Convenience Sampling. The instruments used in this study were pre-test and post-test description questions with data analysis using the T-test. Based on the research, it can be concluded that the implementation of the learning model based on open-ended is conducted very well, with an observer score of 3.46. From the results of the T-test data analysis, it can be seen that the learning model based on open-ended is effective for improving students' mathematical creative thinking skills, it can be seen from the significance value of 0.006 < 0.05, then H0 is rejected and H1 is accepted, which means that the problem-based learning model based on open-ended effective to improve students' mathematical creative thinking skills.

Keywords: Problem-Based Learning model; Open-Ended Approach; Mathematical Creative Thinking Ability.

A. Introduction

Education is a conscious and planned effort as an effort to promote ethics, mind and body in order to promote better perfection in life. According to Law No. 20 of 2003, education is a conscious and planned effort that aims to create a learning atmosphere and the learning process of students actively developing their potentialto have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation, and state.

Educational Objectives are very important in an education, because the purpose of Education is the direction to be aimed or to be achieved in an Education. Therefore, the purpose of education always changes from time to time which is adjusted to the demands of development and development of the lives of the people and the state of Indonesia.

Mathematics is a scientific discipline that systematically examines mindsets, relationship patterns, language, and art which are all studied with logic and are deductive, mathematics can be useful in helping humans in social, economic, and natural problems. Mathematics is one of

the subjects that is considered important to teach because mathematics will require students to think logically, thoroughly, and calculatingly which is useful in everyday life.

The ability to think higher order is a component of thinking ability, which is the ability to process the mind to produce new ideas. According to Beetlestone (1998), the creative aspect of the brain can help explain and interpret abstract concepts, thus allowing students to achieve greater mastery, especially in subjects such as mathematics and science that are often difficult to understand. Thus, it can be concluded that students' creative thinking is one of the aspects that Plays a role in improving students' mathematical creative thinking skills in the field of mathematics.

Many efforts have been made by the government to develop students' creative thinking skills. One of them is in K-13, the government requires that in every learning process must support students to improve students' mathematical creative thinking skills. This is illustrated in the principles of k-13 learning (Permendikbud No. 103, 2014). In 2018 the government presented HOTS type questions of 10% in UN questions, the policy was implemented to train students to use their skillsto think creatively and critically. In addition, government policy also aims to encourage teachers to improve the quality of learning in the classroom.

Indonesia's participation in PISA since 2000 also aims to evaluate and improve the quality of education with students' reading literacy skills, mateamtics skills and science skills in 2015. However, the efforts made by the government have not been directly proportional to the results achieved to improve students' mathematical creative thinking skills. The latest PISA results in 2015 did increase from 275 points in 2012 to 386 points in 2015. However, Indonesia is still in the bottom position, inferior to neighboring countries and even lagging far behind Singapore which occupies the first position.

In the participation of TIMSS (Trends In International Mathematics And Science Study) which aims to evaluate and improve the quality of mathematics and science education in Indonesia. However, the efforts made by the government are still not directly proportional to the purpose of participation in TIMSS. This can be seen from the average mathematics achievement score in Indonesia for 3 periods (1999, 2003-2007, 2011, and 2015) is still low which shows that in general students in Indonesia only know concepts and cannot apply concepts in various problems well in mathematics. So that students can only solve the exact same questions exemplified by the teacher.

Another indicator thatillustrates the weakness of students' mathematical creative thinking skills can be seen from the results of UN mathematics subjects are in the less category. In fact, in general, the UN results of each level have decreased from 2014/2015 to 2017/2018. One of the causes of the decline in UN results is allegedly because the implementation of UNBK has many HOTS questions, where there are many HOTS questions that require reasoning in solving so that it requires students to think more creatively in solving these problems. thus making the difficulty level of the questions higher.

In the ability to think creatively, students are required to be more independent and active in learning. However, now a lot of classroom learning only relies on the teacher, so students are less active and what happens is that students become passive in the learning process. Based on the results of interviews with teaching teachers in class VIII mathematics subjects at MTs N 1 Purbalingga, it is known that students' mathematical creative thinking skills are still low. It can be seen from the results of students' tests and assignments, most of the answers from

students are still ordinary or less varied in answering questions. Students tend to be lazy to solve questions independently, there are no students who ask questions about other ways to solve or solve problems so that students always answer questions in the way the teacher has taught, there is no desire to solve problems with their own thoughts in various ways.

To overcome these problems, an Open-Ended Problem Based Learning model can be applied, where the learning model offers a form of learning that involves students actively in their learning so that students are more creative in solving open-ended based mathematical problems . Where the learning model strongly emphasizes students to be more independent in learning so that students can build their own knowledge, and can create a conducive and fun classroom atmosphere so that students can learn actively and are able to solve mathematical problems related to a problem.

Based on the statements above, researchers are interested in conducting research entitled The Effectiveness of Open-Ended Based Learning Problem Based Models to Improve Mathematical Creative Thinking Skills of Class VIII Mts N 1 Purbalingga Students.

B. Methods

The type of research in this study is quantitative research. Quantitative research refers to the philosophical view of positivism which views that phenomena in research can be classified, measurable, relatively fixed, concrete, observed, and have a relationship of symptoms that are cause and effect. Quantitative research method is a type of research whose specifics are more planned, systematic, and structured more clearly from the beginning to the end of the research. As for those who consider that quantitative research is a study that uses numbers, starting from data collection, interpretation of the data obtained, and the appearance of the results.

The research design used in the study was the Pretest and Posttest Control Group. The research began with the provision of Pretest to the experimental class and the control class, then given mathematics learning to the experimental class using the problem based learning models base on open-ended and the control class using conventional model. After carrying out the entire series of learning, the two classes were given a posttest with the aim of determining the improvement of students mathematical creative thinking skills.

This research was conducted at MTs N 1 Purbalingga located on Jl. Sokawera No. 01, Karanganyar Village, Karanganyar District, Purbalingga Regency, Central Java Province 53354.The learning process carried out for this research was carried out in classes VIII G and VIII H as control classes and experimental classes.

The population is the overall subject of study. If one wants to examine all the elements in the research area, then the research is population research. Stidu or its research is also called population study or census study. The population of this study was MTs N 1 Purbalingga Class VIII students totaling 320 students.

The sample is a portion or representative of the population studied. The sample is also part of the number and character possessed by that population. If the population is large, and it is not possible to study everything in the population, for example due to limited funds, energy and time, then the study can use samples taken from that population. The sample of this study uses the Convenience Sampling Technique, which is sampling where researchers choose

participants because they are willing to be studied. In this case, the researcher cannot say with confidence that the individual is representative of the population. However, samples can provide useful information to answer questions and hypotheses. The samples used in this study were class VIII G numbering 28 and class VIII H totaling 30 students.

The method of collecting data in this study is using observation and tests. Data collection techniques with observation are used when the research deals with human behavior, work processes, natural phenomena and when the observed respondents are not large.

In this case, observations were used to obtain data to see the implementation of open-ended based problem based learning (PBL) models to improve the mathematical creative thinking skills of grade VIII MTs N 1 Purbalingga students. The instrument used to observe the implementation is with an observation sheet assessed by the class teacher and one other observer.

Then to increase the ability of researchers in teaching is calculated by adding up the total score then divided into many aspects in the observation sheet. The following are the basic decision-making guidelines for the implementation of the Problem Based Learning mode base on Open-Ended:

Table 1. Implementation Decision Making Guidelines

Average Score	Implementation Descriptin
$3{,}25 \leq x \leq 4{,}00$	Very Good
$2{,}50 \leq x \leq 3{,}25$	Good
$1{,}75 \leq x \leq 2{,}50$	Good Enough
$1{,}00 \leq x \leq 1{,}75$	Not Good

Then tomeasure the effectiveness of open-ended based problem-based learning models to improve creative thinking skills Student mathematics can be done if they have been given treatment to the experimental group. After being given treatment, researchers will get the data needed to analyze the data. The data will be analyzed using the T test (hypothesis) with the help of SPSS version 16.

The criteria used in the T test are as follows:

If H0 is accepted if the value of $t_{count} \leq t_{table}$, or the value of sig (2-tailed) > α

If H1 is accepted if the value of $t_{count} \geq t_{table}$ or the value of sig (2-tailed) < α

If there is acceptance of H_0, it can be concluded that there is no significant effect, while if H_0 is rejected it means that there is a significant influence. Which means that if H0 is accepted, it means that there is no effectiveness of the Problem Based Learning Model base on open-ended to improve the mathematical creative thinking ability of grade VIII Mts N 1 Purbalingga students.

To improve the mathematical creative thinking ability of grade VIII students of Mts N 1 Purbalingga. And if H_1 is accepted , it means that there is an effectiveness of the open-ended based Problem Based learning model base on open-ended to improve the mathematical creative thinking ability of grade VIII Mts N 1 Purbalingga students.

C. Results and Discussion

1. Implementation data analysis

In this implementation data analysis, it will be explained how to implement an open-ended problem-based learning model on experimental class statistics material. The implementation data was taken from an observation sheet given to two observers, namely Azwar Usman, S.Pd and Inanda Shofa Azahroh. The following are the results of implementation observations filled in by observers:

Table 2. Implementation Observations

No	Observers	Date Of Observation	Total Score	Average Observer Score
1	Observer 1	Thursday, 11 May 2023	46	3,54
2	Observer 2	Thursday, 11 May 2023	44	3,38
Observation Score Results			90	6,92
Averange Observation Score Results			45	3,46

Based on the table above, it can be seen that the observation score obtained from the implementation observations by Azwar Usman, S.Pd. and Inanda Shofa Azahroh is 3.46. Based on the decision-making guidelines in table 3. 9, a score of 3.46 falls into the "Very Good" category. Thus, it can be said that the implementation of problem based learning models base on open-ended in experimental class statistics material is very good.

2. Effectiveness Data Analysis

After the pretest and posstest instruments are tested for validity and reliability, the pretest and posstest can be used to determine the effectiveness of implementation of problem based learning models base on open-ended to improve the mathematical creative thinking skills of grade VIII MTs N 1 Purbalingga students. The following is an analysis of pretest and posstest data after being applied to experimental classes and control classes to determine the effectiveness of problem based learning models base on open-ended to improve mathematical creative thinking skills:

a. Pretest Data Analysis

Pretest is used to measure students' initial ability related to mathematical communication skills before different learning models or treatments are carried out. The following are the pretest results in the experimental class and control class.

Table 3. Pretest Value Comparison Experiment Class and Control Class

No	Experiment Class Code	Pretest Scores	Control Class Code	Peretest Score
1	A1	45	B1	45
2	A2	55	B2	55
3	A3	44	B3	44
4	A4	45	B4	46
5	A5	57	B5	47
6	A6	36	B6	36
7	A7	43	B7	43
8	A8	45	B8	44
9	A9	45	B9	45
10	A10	39	B10	38

11	A11	44	B11	44
12	A12	57	B12	47
13	A13	54	B13	55
14	A14	35	B14	46
15	A15	57	B15	42
16	A16	47	B16	33
17	A17	44	B17	44
18	A18	55	B18	49
19	A19	48	B19	48
20	A20	45	B20	41
21	A21	55	B21	46
22	A22	48	B22	49
23	A23	36	B23	33
24	A24	38	B24	47
25	A25	35	B25	38
26	A26	47	B26	47
27	A27	35	B27	39
28	A28	38	B28	55
29	A29	58	-	-
30	A30	45	-	-
	Sum	1375	Sum	1246
	Average	45.83	Average	44.5
	Higest Score	58	Higest Score	55
	Lowest Score	35	Lowest Score	33

Based on the table above, it can be seen that the lowest scores of the two classes are different, namely 35 and 33, the highest scores of the two classes are also different different, namely for experimental class 58 control class 5 5, and for the average of the two classes are almost the same at 45.83 and 44.5. So it can be said that the creative thinking ability of experimental class students and control classes is the same, and problem based learning models base on open-ended can be applied to experimental classes.

The normality test is a procedure used to determine whether data is normally distributed or not. Test normality using Kolmogorov Smirnov's formula. Results of data analysis using SPSS Version 16 software.

The decision-making guideline in the test is that if the significance number of the Kolmogorov Smirnov Sig. test ≥ 0.05, then the data distributes normally and if the significance number of the Kolmogorov Smirnov Sig. test < 0.05, which means that the data does not distribute normally. Here are the results of the experimental class and control class pretest normality tests:

Table 4. Pretest Normality Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Hasil	.112	58	.069	.946	58	.062

a. Lilliefors Significance Correction

Based on the table above, it can be seen that the significance value of the experimental class is 0,69 > 0.050. So it can be concluded that the pretest results of the two classes are normal

A homogeneity test is performed to find out if the sample comes from a population that has the same variance. A homogeneity test can be performed when the data group is normally distributed.

The decision-making guideline in the test is if the homogeneous test significance number ≥ 0.05 which means homogeneous data and if the homogeneous test significance number < 0.05 which means the data is not homogeneous. In this study, the homogeneity test was carried out using the SPSS Version 16 software application. Here are the homogeneity test results from the pretest data:

Table 5. Pretest Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	2.253	1	56	.139
	Based on Median	1.730	1	56	.194
	Based on Median and with adjusted df	1.730	1	53.970	.194
	Based on trimmed mean	2.221	1	56	.142

Based on the results of the homogeneity test according to the table above, it shows that the significance value (Sig) Based on Mean is 0.139 > 0.050, so it can be concluded that the variant of pretest data for the experimental class and the control class is homogeneous (the same).

The T test is performed after it is known that the data taken is normally distributed data. Then, to test the hypothesis in this study using an independent sample t test using SPSS Version 16 software. This hypothesis test was conducted to determine whether there is an effectiveness of problem based learning models base on open-ended to improve students' mathematical creative thinking skills. The results of the independent sample T test conducted using SPSS Version 16 software are as follows

Table 6. Results of the hypothesis test Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	2.253	.139	.763	56	.449	1.333	1.748	-2.169	4.836
	Equal variances not assumed			.769	54.216	.445	1.333	1.733	-2.141	4.808

Based on the results of the independent sample t test using SPSS Version 16 software above, it can be seen that the value of sig. (2-tailed) 0.449 > 0.05, then ,H-0. accepted and ,H-1.rejected. This shows that the scores of the experimental class and the control class were not significantly different. : It can be interpreted that conventional learning models (lectures) have no effect on the ability to understand mathematical concepts.

b. Postest Data Analysis

Posttest is used to measure students' final ability related to mathematical communication skills after different learning models or treatments in experimental and control classes. Here are the posttest results in the experimental class and control class:

Table 7. Comparison of Experimental Class and Control Class Pretest Values

No	Experiment Class Code	Pretest Scores	Control Class Code	Pretest Scores
1	A1	76	B1	75
2	A2	79	B2	80
3	A3	74	B3	70
4	A4	72	B4	65
5	A5	95	B5	67
6	A6	78	B6	80
7	A7	92	B7	78
8	A8	85	B8	79
9	A9	75	B9	75
10	A10	90	B10	68
11	A11	86	B11	75
12	A12	90	B12	78
13	A13	78	B13	79
14	A14	90	B14	67
15	A15	88	B15	79
16	A16	79	B16	82
17	A17	80	B17	75
18	A18	79	B18	85
19	A19	70	B19	74
20	A20	75	B20	72
21	A21	80	B21	80
22	A22	85	B22	74
23	A23	75	B23	80
24	A24	91	B24	65
25	A25	75	B25	65
26	A26	74	B26	82
27	A27	68	B27	80
28	A28	92	B28	75
29	A29	67		
30	A30	72		
	Sum	2410	Sum	2104
	Average	80.5	Average	75.5
	Higest Score	95	Higest Score	85
	Lowest Score	67	Lowest Score	65

Based on the table above, it can be seen that the lowest scores of the two classes are not the same, namely for the experimental class of 67 and the control value of 65, the highest values of the two classes are different, namely for experimental class 95, control class 85, and for the average of the two classes are also different, namely 80.5 for experimental class and 75.5 for control class. So it can be said that the mathematical creative thinking ability of experimental class and control class students is different, where the posttest results of the experimental class

are higher than those of the control class.

The normality test is a procedure used to determine whether data is normally distributed or not. Test normality using Kolmogorov Smirnov's formula. Results of data analysis using SPSS Version 16 software.

The decision-making guideline in the test is that if the significance number of the Kolmogorov Smirnov Sig. test ≥ 0.05, then the data distributes normally and if the significance number of the Kolmogorov Smirnov Sig. test < 0.05, which means that the data does not distribute normally. Here are the results of the experimental class and control class pretest normality tests:

Based on the table above, it can be seen that the significance value of the experimen class is 0.093 > 0.050. So it can be concluded that the posttest results of both classes are normal.

A homogeneity test is performed to find out if the sample comes from a population that has the same variance. A homogeneity test can be performed when the data group is normally distributed.

The decision-making guideline in the test is if the homogeneous test significance number ≥ 0.05 which means homogeneous data and if the homogeneous test significance number < 0.05 which means the data is not homogeneous. In this study, the homogeneity test was carried out using the SPSS Version 16 software application. Here are the homogeneity test results from the posttest date:

Table 9. Postest homogeneity test results

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	4.345	1	56	.042
	Based on Median	2.939	1	56	.092
	Based on Median and with adjusted df	2.939	1	50.967	.093
	Based on trimmed mean	4.268	1	56	.043

Based on the results of the homogeneity test according to the table above, it shows that the significance value (Sig) Based on Mean is 0.042 < 0.050, so it can be concluded that the posttest data variant of the experimental class and the control class is not homogeneous (not the same).

The T test is performed after it is known that the data taken is normally distributed data. Then, to test the hypothesis in this study using an independent sample t test using SPSS Version 16 software. This hypothesis test was conducted to determine whether there is an effectiveness of problem based learning models base on pen-ended to improve students' mathematical creative thinking skills. The results of the independent sample postest T test conducted using SPSS Version 16 software are as follows:

Table 10 Results of the hypothesis test (independent samples t test)on the posttest question

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	4.345	0.42	2.833	56	.006	5.190	1.832	1.520	8.860
	Equal variances not assumed			2.864	52.986	.006	5.190	1.812	1.555	8.826

Based on the results of the independent sample t test using SPSS Version 16 software above, it can be seen that the value of sig. (2-tailed) 0.006 < 0.05, then H_0 rejected and H_1 Accepted. This shows that the scores of the experimental class and the control class are significantly different. : It can be interpreted that problem based learning models base on pen-ended are effective for improving students' mathematical creative thinking skills.

D. Conclusion

Based on research and discussion, it can be concluded that problem based learning models base on open-ended can be done well, in accordance with the research criteria table and obtained an average of 3.46 which means that it is vulnerable $3.25 \leq X \leq 4.00$, so it is included in the "Very Good" category. So it can be said that the implementation of problem based learning models base on open-ended on experimental class statistics material is very good.

The problem based learning models base on open-ended is effective for improving the mathematical creative thinking skills of grade VIII students. Evidenced by showing that the score scores of the experimental class and the control class were significantly different. And also seen from the results of the t test with a significance value (2-tailed) of 0.006 < 0.05, H 0 was rejected and H 1 was accepted, which means that the problem based learning models base on open-ended is effective for improving the mathematical creative thinking ability of grade VIII MTs N 1 Purbalingga students.

References

Arikunto S. (2002). *Prosedur Penelitian Suatu Pendekatan Praktek*. Jakarta: PT Asdi mahasatya.

Creswell, J W. (2012). *Educational Research Planning, Conducting and Evaluating Quantitative and Qualitative Reaserch*. Nebraska: Pearson.

Fahrurrozi & Hamdi, S. (2017). *Mathematics Learning Methods*. East Lombok : Hamzanwadi University Press.

Hendriana H, Rohaeti E.E., Sumarmo, U. (2017). *Hard Skills and Soft Skills of Mathematics of Students*. Bandung : Refika Aditama.

Hidayat, R. & Abdillah. (2019). *Educational Science Concepts, Theories and Applications*. Medan: Lembaga Peduli Pengembangan Pendidikan Indonesia (LPPPI).

Juanda, R. (2017). *Pengaruh Model Pembelajaran Berbasis Masalah Terhadap Hasil Belajar Matematika Siswa Kelas V SD N Gugus Wijayakusuma Ngaliyan Semarang*. Semarang : Univeritas Negeri Semarang.

Kariandinata R. & Abdurahman, M. (2015). *Fundamentals of Educational Statistics*. Bandung : CV Pustaka Setia.

Krestiwi, K. (2017). The influence of problem-based learning models in cultivating metacognisis and improving students' mathematical creative thinking skills in grade VII Mts N Jakarta *Journal of Mathematics Education*. Vol. 5, N0.3.

Lumbantobing, F. (2018). *The Effect of the Problem-Based Learning Model on the Mathematical Problem Solving Ability of Class VIII Students of Mts Private Islamiyah Urung Pane Kecamatan Setia Janji Kebupaten Asahan T.P 2017-2018*. Medan: UIN North Sumatra Medan.

Nurdyansyah & Fahyuni, E.F. (2016). *Learning Model Innovation According to the 2013 Curriculum*. Sidoarjo : Nizama Learning Center.

Nurlaela, L. & Ismayati, E. (2015). *Creative Thinking Strategies*. Yogyakarta: Ombak Publisher (Member of IKAPI).

Nuryadi, A.T.D., et al. (2017). *Basics of Research Statistics*. Yogyakarta : Gramasurya.

Ridho, M. (2006). *Independent Integrated Evaluation and Junior High School Mathematics Recreation*. Jakarta : PT Grasindo.

Sani, R A. (2014). *Inovasi Pembelajaran*. Jakarta : PT Bumi Aksara.

Sofyan, H., et al. (2017). *Problem Based Learning in the 2013 curriculum*. Yogyakarta : UNY Press.

Sugiyono. (2020). *Quantitative, Qualitative and R&D Research Methods*. Bandung: ALFABETA.

Umar, A. & Ahmad, N Q. (2019). Analysis of Mathematical Creative Thinking Ability of Mathematics Teacher Candidates. *Journal of As-Salam* Vol. 3, No. 1.

Wahyudi, Verawati, N.N.S.P., Ayub, S. (2018). *Inquiry Creative Process A study of learning models to develop critical thinking skills*. Lombok : Duta Pustaka Ilmu.

Wijayanti R., et al. (2021). *Quantitative Research Methods*. East Java : Widya Gama Press.

Zulkifli N.Z. (2015). *Qualitative and quantitative research methodologies*. Yogyakarta : CV Budi Utama.

This page has been intentionally left blank.

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 67-80
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

The Integration of GeoGebra in Problem-Based Learning to Improve Students' Problem-Solving Skills

Joko Suratno[1]✉, Ida Kurnia Waliyanti[1]

[1]*Universitas Khairun, Ternate, Indonesia*

✉ *Corresponding email: joko_unkhair@yahoo.co.id*

Received June 5, 2023
Accepted July 4, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8514

Abstract: Learning mathematics requires the development of problem-solving abilities. However, problem-solving requires additional focus, particularly in the context of schools. Therefore, alternatives are needed to teach students how to solve problems through GeoGebra in problem-based learning. The goal of this study was to thoroughly and in-depth investigate how the use of GeoGebra in problem-based learning affects grade 8 students' capacity for problem-solving. Quasi-experimental research methodology is employed. The Posttest-Only Design with Nonequivalent Groups was the quasi-experimental design in this work. The quasi-experimental design in this study did not use pre-tests. This is due to the possibility that the initial test can affect the final test results. According to the data analysis, incorporating GeoGebra into problem-based learning significantly impacts students' ability to solve problems (p-value < 0.05).

Keywords: GeoGebra; problem-based learning; problem-solving.

A. Introduction

The science of mathematics plays various roles in people's and society's growth (Fatima, 2015). A person must cooperate and communicate with others in a social setting. Transactions and other activities, the majority of which cannot be separated from mathematics, can be considered types of cooperation and communication that take place. Additionally, humans need mathematics to further their cerebral development. Math problem-solving exercises aid in the development of pupils' thinking skills. These exercises will develop a positive, inventive mindset. Later on, this procedure would impact pupils' mental capacities in daily life.

Numerous societal areas, such as education, economic development, and science and technology, demonstrate the value of mathematics. Math is studied or required in practically every topic and course in education. Mathematics supports economics in terms of economic growth. In the development of science and technology, mathematics is used extensively in business and financial services, and as a result, science and technology are present. From social sciences to medical and medical sciences, mathematics is widely used in various scientific fields. The advancement of science and technology in this century has also made successful

use of mathematics. This is demonstrated using mathematics in multiple domains, such as planetary exploration and biotechnology.

Mathematics must be continually improved to generate the range of mathematical knowledge needed by humanity as a force supporting science and technology. Various tools and technologies can be used in conjunction with this knowledge. Therefore, the need for additional mathematical expertise to enhance human life is excellent. Mathematicians play a crucial part in this talent, and the more mathematicians there are, the newer skills there are to learn.

One of the ways to create many mathematicians is by nurturing and educating students in solving mathematical problems in schools. Therefore, teachers need to increase their role in improving problem-solving skills in mathematics. However, most mathematics teachers currently produce students or graduates. One strategy for creating many mathematicians is to encourage and train pupils to solve mathematical problems in the classroom. As a result, teachers need to play a more significant part in enhancing students' ability to solve mathematical problems. However, most math instructors today generate graduates or students who need more knowledge or expertise to solve complex problems (Xavier, 2013). Additionally, even though some mathematics textbooks use conjectures in the presentation of the topic, modern educational activities have largely stripped mathematics of its distinctive features. This is evident from the simplified mathematical algorithms the teacher uses to explain the material, from the fact that students rarely learn why definitions, examples, theorems, and proofs are significant or fascinating, and from their perception that learning mathematics consists only of learning rigid rules and procedures (Wilson, 2003).

Only some students need to be math experts or have a strong math background. To deal with technological advancements and the advancement of the times, pupils must learn mathematics from a young age. As a result, teaching kids problem-solving abilities is crucial if they can recognize patterns in the continuously shifting, uncertain, and competitive world of real life. Students are expected to be able to forecast and resolve an issue that will be and is currently being encountered by identifying ways that occur in daily life.

Only in a suitable learning environment is problem-solving feasible in classroom learning activities. It is more likely to be employed as a problem-solving method because the national school curriculum requires a multi-strategy approach and technology. However, the fact that instructors' learning methods have stayed the same since then is daily news. Teachers of mathematics still provide material using traditional methods. Most math instructors rarely use technology in their lessons; hence the adoption of technology in math instruction advances relatively slowly. Additionally, some teachers have access to computers and the right software at work and home; nevertheless, the facilities and technology already in place are rarely incorporated into classroom instruction by the teachers (Zilinskiene & Demirbilek, 2014). Some teachers have access to computers and the right software at work and home, but they only sometimes incorporate the available resources into classroom instruction (Hardy, 1940).

The characteristics of learning activities that allow for improving problem-solving skills are learning activities in which there are activities that they enable students to be able to make observations. Of course, these observations are based on a task/activity and a problem that allows students to obtain different results, make mistakes, make improvements, and conclude the effects they have received. One alternative learning approach with these

characteristics is problem-based learning (PBL) because, in PBL, it is possible to find several problem-solving solutions, which are the completion of a problem or activity. In addition, involving teachers in experimentation/observation activities and pain-solving with PBL provides teachers with new experiences about PBL. Exciting adventures and successful use of PBL are expected to encourage teachers' willingness to use PBL in their teaching activities (Cazzola, 2009). Besides PBL, technology can also be used in problem-solving activities (Colton, 2007).

Technology has affected the world of education at this time. This is due to the availability of various hardware and software and facilities or information and communications technology (ICT) that students can use for learning. ICT at least influences school subjects, knowledge, curriculum, how experts work, how teachers teach, how students work individually and in groups, and how students learn. This influence has consequences for teacher competence and implications for teacher education. Teachers must also be able to use these technologies in the classroom and laboratory (Cornu, 1999).

One of the technologies that teachers in classroom learning activities can use is the GeoGebra dynamic mathematics software. GeoGebra can be used in active and problem-oriented learning (Majerek, 2014). According to Evans (May 2013), the GeoGebra developer hopes that mathematics will be easy to understand with this software. He also wanted to show students that mathematics is beneficial and exciting. With GeoGebra, students can play with math. They can do something quickly, shift points wherever they want, can experiment with mathematics, and it is hoped that this method will make students understand better. Therefore, introducing GeoGebra is the right way to improve the quality of learning and is expected to improve student learning outcomes so that they are better (Kyeong, 2010; Ljajko, 2013). In addition, GeoGebra allows students to see abstract concepts, make connections, and discover mathematics (Antohe, 2009).

Padmavathy and Mareesh (2013) said that PBL has a more effective influence on learning mathematics than conventional learning in increasing students' understanding and use of mathematical concepts in real life. In addition, Leinwand and Burrill (2001) added that technology is essential in learning mathematics. However, integrating the GeoGebra dynamic mathematics software into learning activities with the PBL approach is challenging. More material on PBL training (Ward & Lee, 2002) and the availability of a computer laboratory are needed to guarantee the implementation of regular use of computers in classroom learning (Leikin & Zazkis, 2010). According to So and Kim (2009), several things that need to be improved in integrating technology into PBL are the lack of ability to connect ideas, knowledge, and action and the lack of teaching resources that integrate technology with PBL. Someone who can effectively integrate technology into learning usually has a good mastery of technology. However, someone with good skills in mastering technology can only sometimes use these skills in teaching. Therefore, it is indispensable for a teacher to master technology and how to use it in learning to achieve the objectives of learning activities.

One effort to encourage mathematical software to be used regularly in classroom learning is to train teachers to use the software (Gawlick, 2002). Kennedy et al. (2008) added that the correct use of computers and programs that are effective in learning would benefit students when learning using computers is applied in the classroom. However, computers will not help much if the software is not combined with the proper learning techniques. For

example, student-centered learning methods, active learning methods, and learning through skills, practice, and experimentation.

The designed research is expected to provide new learning experiences in developing students' problem-solving abilities. Problem-solving in this study can be done with various learning activities. These activities can be in the form of activities to produce concepts, conjectures, theorems, and proofs. Identifying the shortcomings of a theorem, simplifying a proof, generating a new proof method, and finding techniques for constructing a concept can also be seen as problem-solving activities (Colton, 2007).

Creative learning activities to bring up mathematical problem-solving skills are closely related to mathematical situations or problems that can bring out the creativity in the classroom. The mathematical situations or problems in question are at least situations and problems familiar to everyday life. In addition, the situations and problems presented can be manipulated so that students can explore, provide sources of information for student questions, and provide materials and equipment that will encourage students to do experiments. Another thing that will be done is giving time to students to be able to manipulate, discuss, and experiment, encourage students not to be afraid of making mistakes that can later be corrected, and produce conclusions or success from these activities. Providing guidance, reflection, and reinforcement of students' ideas and hypotheses is also vital, in addition to providing positive feedback on student work. Researchers or teachers must know when or in what situations a student should be given guidance or assistance. Reflection is needed in students' understanding of the material provided, and reinforcement broadens or deepens students' mastery and knowledge of particular studies. Therefore, this research aims to provide new learning experiences so students can creatively produce problem-solving. This is done by combining problem-based learning with GeoGebra dynamic mathematics software, which aims to improve problem-solving skills.

B. Methods

The research method used is quasi-experimental. The main difference between this research and pure experimental research lies in placing individuals into groups. In experimental research, individuals are randomly selected to minimize bias. If individual selection is deemed impossible or impractical, quasi-experimental research is the right choice (Cohen et al., 2007; Muijs, 2004). Because the quasi-experimental design does not provide complete control, researchers need to pay attention to the factors that affect internal and external validity in interpreting the results of their research (Ary et al., 2009).

This study consisted of independent variables, namely problem-based learning assisted by technology, and the dependent variable, namely problem-solving skills. The quasi-experimental design used in this study was a Post-test-Only Design with Non-equivalent Groups (Prancan & Wise, 2002), as shown below.

NR X O_1

NR O_2

Information:

NR	=	*Nonrandom* (Not Random)
X	=	Problem-Based Learning Assisted GeoGebra
O1 = O2	=	Problem Solving Ability Test

The dotted line between the two sample classes, namely the experimental class and the control class, indicates that the two classes were not formed by randomly placing individuals or research subjects into sample classes (Prancan & Wise, 2002). Students who were subjects in the experimental class were taught using problem-based learning assisted by technology (X). In contrast, students used as research subjects in the control class were taught traditionally. At the end of the learning activity, students in both sample classes were given a final test (O1 = O2), namely a test to measure their problem-solving abilities.

The quasi-experimental design in this study did not use pre-tests. This is due to the possibility that the initial test can affect the final test results (Lana cit. Prancan and Wise, 2002). In addition, the problem-solving ability test is an unusual test for students. Students need to be trained in completing tests or questions of this type in the learning process. Therefore, giving the initial test in this study was eliminated.

This study's population was all class VII SMP Islam 1 Kota Ternate students. The experimental research class was class VII8, with a total of 21 students and the control class was class VII11, with 25 students with purposive sampel test. Before being given treatment, an initial mathematical ability test was carried out on the experimental and control classes. Based on data analysis on the results of this test, it is known that there is no significant difference in initial mathematical abilities between the two sample classes, so the two sample class groups are eligible to be used as research sample classes.

The main instruments of this research are Mathematical Preliminary Ability Tests and Problem-Solving Ability Tests. The initial mathematical ability test is used to measure students' understanding of the material studied and is thought to be supporting material in mastering the material of Triangles and Quadrilaterals. These materials include Numbers, Algebra, Lines and Angles, and Cartesian Coordinates.

The total number of items is 30. Before being tested, three experts assessed the test's quality. The assessment includes the suitability of the questions with the indicators; suitability of the material in question with competence; homogeneous and logical answer choices; the number of answer keys; formulation of the subject matter; suitability of the primary question formulation and answer choices; whether there are answer essential instructions; whether there are statements that are double negative in the main question; selection of homogeneous and logical answers in terms of material; clarity and functionality of pictures, graphs, tables, diagrams, or the like in the items that present them; the length of the answer choices; use of answer choices; sorting of answer choices; the dependence of the item on the answer to the previous question; the use of language in accordance with the rules of the Indonesian language; use of communicative language; use of local/taboo language; the selection of answers does not repeat the same word/group of words, unless it constitutes a unified understanding.

The three assessors stated that the items assessed were by the criteria in terms of suitability of the items with the indicators; suitability of the material in question with competence; homogeneous and logical answer choices; formulation of the subject matter;

whether there are answer essential instructions; whether there are statements that are double negative in the main question; selection of homogeneous and logical answers in terms of material; the length of the answer choices; use of answer choices; sorting of answer choices; the dependence of the item on the answer to the previous question; the use of language by the rules of the Indonesian language; use of communicative language; use of local/taboo language; the selection of answers does not repeat the same word/group of words unless it constitutes a unified understanding.

There are differences between the three assessors in terms of assessing the quality of the items in terms of the number of answer keys; suitability of the leading question formulation and answer choices; and the clarity and functionality of pictures, graphs, tables, diagrams, or the like in the items that present them. Therefore, the opinions of the three assessors need to be tested for diversity using the Q -Cochan statistic. The Q -Cochan test is used because the data from the three experts are dichotomous (Siegel, 1956). The analysis results show that the criterion for the number of answer keys shows the Asymp value. Sig. 0.465; the suitability of the main questions and the answer choices shows the Asymp value. Sig. 0.392; the clarity and functionality of pictures, graphs, tables, diagrams, or the like in the items that present them show the Asymp value. Sig. They amounted to 0.465. This shows that the probability value (sig.) is more significant than 0.05. Therefore, the three assessors gave uniform considerations that there was only one answer key, the main questions and answer choices were only necessary statements, and the image was clear and working. In addition, two out of three raters stated that the instrument could be used without revision, and one rater stated that the instrument could be used with minor revisions. Therefore, the researcher concluded that the instrument could be used without revision.

Problem-solving ability test tests will determine students' problem-solving abilities, including concepts, conjectures, theorems, proofs, simplification of proofs, and new method skills. Before use, this problem-solving ability test is tested for quality. The examiners are three experts. The assessment includes the suitability of the items with the indicators; suitability of question and answer limits; suitability of the material in question with competence; suitability of the content of the material being asked for with the level, type of school or class level; the use of question words or orders; clarity of how to do the questions; the existence of scoring guidelines; the communicativeness of the question sentence formulation; use of Indonesian; the use of words that will lead to multiple interpretations or misunderstandings; use of local/taboo language; and the use of words/expressions that can offend students.

The three assessors stated that the four items assessed had shown the suitability of the items with the indicators; suitability of question and answer limits; suitability of the material in question with competence; suitability of the content of the material being asked for with the level, type of school or class level; use of Indonesian; use of local/taboo language; and the use of words/expressions that can offend students. However, there are still differences among raters about assessing the items in terms of the use of question words or commands which requires explanatory answers; there are clear instructions on how to do the questions, there are scoring guidelines, the communicativeness of the formulation of the question sentences, and the use of words that will lead to multiple interpretations or misunderstandings. Therefore, it is necessary to test the uniformity of the assessment of the four assessors using Q-Cochran statistics.

The results of the analysis using the Q-Cochan statistics show that the criteria for using question words or commands, clarity on how to do the questions, communicativeness of the formulation of the questions, the use of words that will lead to multiple interpretations or misunderstandings all four have an Asymp value. sing. of 0.392, and the criteria for the existence of a scoring guideline shows the Asymp value. sing. of 1,000. This shows that the probability value (sig.) is more significant than 0.05. Therefore, it can be concluded that the three assessors gave uniform considerations that the four items used question words or commands that demanded detailed answers, there were clear instructions on how to do the questions, the communicative formulation of the questions, the use of words that would lead to multiple interpretations or misunderstanding, and there is a scoring guideline. In addition, two out of three raters stated that the instrument could be used with minor revisions and one rater stated that the instrument could be used without revision. Therefore, the researcher concluded that the instrument could be used with minor revisions.

Research data on students' problem-solving abilities will be analysed using SPSS (Statistical Product and Service Solution) assistance. Before testing, there will be the detection of outliers as well as testing of normality assumptions and homogeneity of the variance of research data, namely data on students' problem-solving abilities.

Outliers are detected using standard scores. Datums with standard scores around an absolute value of three should be suspected as outliers. This is because approximately 99% of normally distributed data should lie within three standard deviations of the average (Stevens, 2002). Therefore, data with a standard score of around three will be given special attention later.

The assumption of normality is a requirement of most inferential statistical procedures. SPSS provides two normality test formulas: the lilliefors normality test (Kolmogorov-Smirnov) and the Shapiro-Wilk Normality Test. In addition, a variance homogeneity test will also be carried out, both of which will be used to carry out the type of test that will be used next, namely parametric or non-parametric tests. If the assumptions of normality and homogeneity are met, the research hypothesis will be tested by paired-sample t-test with SPSS 20. If the assumptions of normality or homogeneity are not met, then the research hypothesis will be tested by the Mann-Whitney test.

C. Results and Discussion

The main objective of this study was to determine the impact of GeoGebra-assisted problem-based learning (PBL) on students' problem-solving abilities. The number of schools involved in this research is one. From these schools, two classes were selected as research samples. One of the two classes learns with GeoGebra-assisted problem-based learning (PBL+G), and the other learns conventionally. At the end of the learning activity, a test was carried out to measure student learning outcomes in the form of a problem-solving ability test. Table 1 below shows data on students' problem-solving abilities from the two class groups.

Table 1. Data of Students' Problem-Solving Ability

Approach	PSS average	Deviation Standards	The number of students

PBL+G	7,10	4,979	21
conventional	5,36	4,154	25

Notes. PSS = Problem Solving Skills
PSS Maximum Score = 23

The research data shows that the average problem-solving skills (PSS) of students in the PBL+G class is higher when compared to the PSS of students in conventional classes. Even so, the range of student scores in the PBL+G class looks more spread out than in the conventional class. This can be seen from the standard deviation of the PBL+G class, which is higher than the conventional class.

The PSS value in this study has the lowest value of 0 and the highest value of 23. When viewed from the maximum value of the PSS, the average value of PSS for the PBL+G class can be categorized as being in a low category, and the average value of the conventional class descriptively can be categorized in the value criteria as very low.

The assumption of normality is a requirement of most inferential statistical procedures. This study uses the SPSS 20 in carrying out the normality test. The groups to be tested were the PBL+G class and the conventional class.

Based on the normality test conducted on the PSS values, it was found that the PBL+G class showed a p-value < 0.05 for the Lilliefors (Kolmogorov -Smirnov) normality test and a p-value < 0.05 for the Shapiro-Wilk normality test. Both p-values are smaller than 0.05, so the PBL+G class data does not come from a normally distributed population. On PSS value for the conventional class, a p-value <0.05 was obtained for the Lilliefors (Kolmogorov-Smirov) normality test and a p-value < 0.05 for the Shapiro-Wilk normality test. Both p-values are smaller than 0.05, so conventional class data do not come from normally distributed populations for the Lilliefors (Kolmogorov-Smirov) normality test and the Shapiro-Wilk normality test.

The next test is for the similarity of variance or homogeneity of variance. The class being compared is the PBL+G class and the conventional class. The homogeneity test of student PSS data variance shows that the p-value for the variance homogeneity test is more significant than 0.05. This shows that the two groups, PBL+G and conventional, have the same variance. Even though the two groups have the same variance, they do not come from normally distributed populations. Based on the normality test and homogeneity of variance of PSS data, the statistical test used in this analysis is a nonparametric test. The nonparametric test used is the Mann-Whitney test. The Mann-Whitney test is an alternative to the independent two-sample t-test. Based on the analysis, it is known that ¬the p-value for the two-tailed test is less than 0.05, so it can be concluded that there is significant difference between the problem-solving abilities of PBL+G class students and conventional classes.

The main objective of this study was to determine the impact of GeoGebra-assisted problem-based learning on students' problem-solving skills. Therefore, various learning tools and research instruments were designed and prepared to achieve the intended research objectives. After making teaching materials, the next step is assessing the quality of teaching materials that have been made by involving several experts.

The research was conducted in a school involving 46 students. A total of one PBL+G class and one conventional class were selected from the school. At the end of the study, a

learning achievement test was carried out to measure students' problem-solving abilities. The results showed no significant difference between classes taught by GeoGebra-assisted problem-based learners and classes taught by conventional methods. Thus GeoGebra-assisted problem-based learning has no impact on students' problem-solving abilities.

This study's ability to solve problems reflects a mathematical understanding consisting of four indicators. The four indicators used as tools to measure problem-solving abilities are finding, exploring, and interpreting the relationship between the properties of the angles in triangles and lines for triangles; finding, exploring, and interpreting the relationship between the properties of the midpoints of the sides of a quadrilateral and the shapes formed by the midpoints; discover, explore and interpret the relationship between the properties of a diagonal line and the area divided by the diagonal of a parallelogram; and find, explore, and interpret the properties of lines that are formed based on the relationship between diagonal lines, gravity lines, and lines that are parallel to the sides of the base of the trapezoid.

The first item indicator is finding, exploring, and interpreting the relationship between the properties of angles in triangles and lines for triangles. These indicators are used as guidelines in the formulation of the desired questions. In formulating the problem, the researcher chose an isosceles triangle which would be used as a problem that students had to solve. According to von Glasersfeld (2000), knowledge can only result from experience. Efforts to provide experience with problem-based learning assisted by GeoGebra mathematical software to gain knowledge about problem-solving have yet to meet expectations. This relates to basic skills students have not fully mastered, such as understanding symbols and terms in plane shapes and naming and types of plane shapes. Therefore, the effort to improve it is to reconstruct (Piaget, 1970) this basic knowledge through an improved learning design so that the advantages of PBL can be maximized. An example is maximizing the role of cooperation in groups where individuals can help one another construct knowledge through social and cultural interaction (Mason & Johnston-Wilder, 2004).

Essential knowledge that students have mastered is necessary for making conjectures by following the instructions in the problem correctly. Some of the students in this study indicated that they did not follow the instructions, and others still had problems using writing aids, such as compasses and protractors. Even though finding conjectures is the first step in finding mathematics (Wu & Chen, 2009), students' limited abilities will cause obstacles to getting the expected conjectures.

Analysis of students' problem-solving abilities between classes taught with GeoGebra-assisted problem-based learning and conventional classes on the four indicators of problem-solving ability showed no significant difference between the two groups in each indicator of problem-solving ability.

There are striking differences between the results of this study with several previous studies. Previous studies have shown that problem-based learning has increased students' mathematical abilities. Noer (2010) concluded that the quality of improving critical, creative, and reflective mathematical thinking skills and learning independence of students who received mathematics learning using problem-based learning was better than students who studied mathematics conventionally. Problem-based learning also results better than conventional learning in improving mathematical communication, problem-solving, and students' mathematical dispositions (Karlimah, 2010).

Armiati (2011) concluded that problem-based learning is superior to conventional learning in improving students' mathematical reasoning abilities, mathematical communication, and emotional intelligence. The ability of problem-solving, communication and mathematical representation of students who get problem-based learning are better than students who get conventional learning (Sabirin, 2011).

Combining problem-based learning with other models or strategies also shows promising results. This can be shown by the high-level mathematical thinking skills and independence of students whose learning uses a problem-based approach with a Jigsaw-type cooperative setting better than the high-level mathematical thinking abilities of students whose learning uses a problem-based approach (Ismaimuza, 2010). Sugandi (2010) also concluded that the critical thinking skills, creative mathematics, and attitudes of students who received problem-based learning with cognitive conflict strategies were better than students who received conventional learning. This combination implies that problem-based learning is a learning approach that does not rule out the possibility of being combined with other learning strategies or learning aids.

The results above show that a good learning approach or method successfully applied in a place is not necessarily appropriate or suitable for application in places, subjects, school levels, or other materials. Researchers who wish to study research related to technology must consider several things. First is selecting the correct method or approach to a subject matter and developing the student's abilities. This requires thinking about how to see the problems faced by students to find alternative solutions. The second is the allocation of time between activities in the laboratory and class. The amount of time spent in laboratory activities will undoubtedly affect students' ability to be measured.

Learning activities entirely spent in front of the computer will undoubtedly affect students' abilities or skills in using geometric construction tools, such as rulers, compasses, and arcs. One of the researchers' recommendations for researchers who study geometry problems with technology is that it is necessary to conduct research that examines the impact of the number of learning activities in the computer laboratory on students' abilities or skills in painting or constructing geometric objects and finding out the ideal percentage between the number of hours of activity in the laboratory and class so that students' skills in constructing geometric objects both using technology and manually are maximized.

D. Conclusion

The main objective of this study was to determine the impact of GeoGebra-assisted problem-based learning on students' problem-solving abilities. In general, this research activity has been carefully prepared, starting from the design and development of teaching materials and instruments, expert validation, and trials that conclude that the developed teaching materials and instruments are feasible and can be used further. This research took approximately four months. The first two months are used for testing teaching materials, and the remaining two months for field research. Based on the results of data analysis, students' problem-solving abilities through problem-based learning assisted by GeoGebra are significantly different from students' skills abilities through conventional learning. Although a

descriptive review of the average PSA scores shows differences in the criteria for average scores between PBL+G and conventional classes, the characteristics of the data do not allow data on students' problem-solving abilities to be tested with parametric statistics. Therefore, the parameter used as a reference is the median data from the two study sample groups. Based on the nonparametric test of these parameters, it was concluded that there was significant median difference between the two study groups being compared. So, GeoGebra-assisted problem-based learning affect students' problem-solving abilities. The number of activities in class and the laboratory is the same: five meetings each. Therefore, it is necessary to pay attention to the number of meetings between the class and the laboratory. This study has yet to maximize teaching materials and learning tools that have been compiled, developed, and tested with good results. Therefore, researchers interested in using technology in learning need to pay attention to the number of meetings in the classroom and the laboratory because this will relate to the abilities of the students to be measured.

References

Antohe, V. (2009). Limits of educational soft "komputer" in a critical constructive review. *Computer Science Series, 7,* 45–54.

Armiati. (2011). *Peningkatan kemampuan penalaran matematis, komunikasi matematis, dan kecerdasan emosional mahasiswa melalui pembelajaran penemuan terbimbing*. Universitas Pendidikan Indonesia.

Ary, D., Jacobs, L. C., & Sorensen, C. (2009). *Introduction to research in education* (8th ed.). Wadsworth, Cengage Learning.

Cazzola, M. (2009). Problem-based learning and teaching training in mathematics: The role of the problem. In M. Tzekaki, M. Kaldrimidou, & H. Sakonidis (Eds.), *Proceedings of the 33rd conference of the international group for the psychology of mathematics education*. PME.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. Routledge.

Colton, S. (2007). Computational Discovery in Pure Mathematics. In S. Dzeroski & L. Todorovski (Eds.), *Computational Discovery of Scientific Knowledge* (pp. 175–201). Springer-Verlag Berlin Heidelberg.

Cornu, B. (1999). Training today the teacher of tomorrow. In C. Hoyles, C. Morgan, & G. Woodhouse (Eds.), *Rethinking the mathematics curriculum* (pp. 195–202). Falmer Press.

Fatima, R. (2015). *Role of mathematics in the development of society*. http://www.ncert.nic.in/pdf_files/Final-Article-Role of Mathematics in the Development ofSociety-NCER-.pdf

Gawlick, T. (2002). On dynamic geometry software in the regular classroom. *ZDM*, *34*(3), 85–92.

Hardy, G. H. (1940). *A Mathematician's apology*. University of Alberta Mathematical Sciences Society.

Ismaimuza, D. (2010). *Kemampuan berpikir kritis dan kreatif matematis siswa smp melalui pembelajaran berbasis masalah dengan strategi konflik kognitif (Disertasi)*. Universitas Pendidikan Indonesia.

Karlimah. (2010). *Pengembangan kemampuan komunikasi dan pemecahan masalah serta disposisi matematis mahasiswa PGSD melalui pembelajaran berbasis masalah*. Universitas Pendidikan Indonesia.

Kennedy, L. M., Tipps, S., & Johnson, A. (2008). *Guiding Children's Learning Mathematics* (11th ed.). Thomson Wadsworth.

Kyeong, S. C. (2010). Motivating students in learning mathematics with geogebra. *Computer Science Series*, *8*(2), 65–76.

Leikin, R., & Zazkis, R. (2010). Teachers' opportunities to learn mathematics through teaching. In R. Leikin & R. Zazkis (Eds.), *Learning through teaching mathematics: Development of teachers' knowledge and expertise in practice* (pp. 3–22). Springer.

Leinwand, S., & Burrill, G. (2001). *Improving mathematics education: resources for decision making*. National Academy Press.

Ljajko, E. (2013). Development of ideas in a geogebra: Aided mathematical instructions. *Mevlana International Journal of Education*, *3*, 1–7.

Majerek, D. (2014). Application of geogebra for teaching mathematics. *Advances in Science and Technology*, *8*(24), 51–54.

Mason, J., & Johnston-Wilder, S. (2004). *Fundamental constructs in mathematics education*. RoutledgeFalmer.

Muijs, D. (2004). *Doing qualitative research in education with SPSS*. SAGE Publications Ltd.

Noer, S. H. (2010). *Peningkatan Kemampuan berpikir kritis, kreatif, dan reflektif matematis siswa smp melalui pembelajaran berbasis masalah*. Universitas Pendidikan Indonesia.

Padmavathy, R. D., & Mareesh, K. (2013). Effectiveness of problem-based learning in mathematics. *International Multidisciplinari E-Journal*, *2*(1), 45–51.

Piaget, J. (1970). Genetic Epistemology. In *Genetic Epistemology*. Columbia University Press. https://doi.org/10.7312/piag91272

Prancan, K., & Wise, S. (2002). *Experimental dan quasi-experimental designs for generalized causal inference*. Houghton Mifflin Company.

Sabirin, M. (2011). *Pengaruh pembelajaran berbasis masalah terhadap kemampuan pemecahan masalah, komunikasi, dan representasi matematis siswa smp.* Universitas Pendidikan Indonesia.

Siegel, S. (1956). *Nonparametric statistics for the behavioral sciences*. McGraw-Hill Book Company, Inc.

So, H. J., & Kim, B. (2009). Learning about problem based learning: Student teachers integrating technology, pedagogy and content knowledge. *Australasian Journal of Educational Technology*, *25*(1), 101–116.

Stevens, J. (2002). *Applied multivariate statistics for the social sciences* (4th ed.). Laurence Erlbaum Associates, Inc.

Sugandi, A. I. (2010). *Pengaruh pembelajaran berbasis masalah dengan setting kooperatif tipe jigsaw terhadap pencapaian kemampuan berpikir matematik tingkat tinggi dan kemandirian belajar siswa sma*. Universitas Pendidikan Indonesia.

von Glasersfeld, E. (2000). Problems of constructivism. In *Radical constructivism in action: Building on the pioneering work of Ernst von Glasersfeld* (pp. 3–9). RoutledgeFalmer.

Ward, J. D., & Lee, C. L. (2002). A review of problem-based learning. *Journal of Family and Consumer Sciences Education*, *20*(1), 16–26. http://www.natefacs.org/JFCSE/v20no1/v20no1Ward.pdf

Wilson, S. M. (2003). *California dreaming: Reforming mathematics education*. Yale University Press.

Wu, C. J., & Chen, J. C. (2009). Enhancing students' geometric conjectures by systematic searching. In M. Tzekaki, M. Kaldrimidou, & H. Sakonidis (Eds.), *Proceedings of the*

33rd Conference of the International Group for the Psychology of Mathematics Education (p. 503). PME.

Xavier, D. (2013). *Better ways of teaching mathematics to the students at primary level*. http://xavierdhs07.hubpages.com/hub/Better-ways-of-teaching-Mathematics-to-the-Students

Zilinskiene, I., & Demirbilek, M. (2014). Use of GeoGebra in primary math education in Lithuania: An exploratory study from teachers' perspective. *Informatics in Education*, *14*(1), 127–142.

This page has been intentionally left blank.

International Journal of Research in Mathematics Education
Vol. 1 No. 1, July 2023, 81-94
Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto
e-ISSN: 3025-7638, p-ISSN: 3025-1842

Analysis of Problem-Solving Ability Based on Polya Stages of Open University Students in Mathematics Courses

Nur'aini Muhassanah [1]✉, Ambar Winarni[1]

[1]*Universitas Nahdlatul Ulama Purwokerto, Purwokerto, Indonesia*

✉ *Corresponding email:* *nuraini.muhassanah8790@gmail.com*

Received June 13, 2023
Accepted July 4, 2023
Published July 31, 2023

https://doi.org/10.24090/ijrme.v1i1.8618

Abstract: This type of research is qualitative research using a descriptive approach. The purpose of this research is to describe the problem-solving skills of the Polya stages in Mathematics courses. The subjects of this study were 15 students in the 3rdsemester of the Open University, Elementary School Teacher Education Study Program. They were divided into three categories of problem-solving abilities, namely 6 students (40%) in the high category, 6 students (40%) in the medium category, and 3 students (20 %) low category. Data related to problem-solving abilities according to Polya's stages were obtained from diagnostic tests and interviews. Subjects were taken by purposive sampling technique and data validation using triangulation. Data analysis techniques used data reduction, data presentation, and conclusion. The results of this study were 12 students (80%) who were in the high and medium categories were able to write down what was known and asked about the questions correctly, present the sequence of steps for solving using the proper steps or procedures and get the correct results, and write conclusions without writing checks. Whereas 3 students (20%) in the low category incompletely wrote what was known and asked about the questions, the sequence of solutions presented was inaccurate, wrote the procedures or steps but were incorrect, and wrote conclusions with the answers given were incorrect.

Keywords: Problem-Solving; Mathematic; Understanding; and Planning.

A. Introduction

The rapid development in today's technology is also underpinned by developments in mathematics in various fields, such as number theory, algebra, analysis, probability theory, and discrete mathematics. To master and create technology in the future, strong mastery of mathematics is needed from an early age. Therefore, mathematics is one of the important subjects that must be taught in schools, starting from the basic education level to the higher education level (Chang, Y. L., & Huang, Y. I., 2014). According to Abdurrahman (2003) Mathematics is a symbolic language whose practical function is to express quantitative and spatial relations while its function is to facilitate thinking. In education, students' abilities are honed through problems, so that students are able to improve the various competencies they have.

One of the objectives of learning mathematics is to develop problem solving abilities. This indicates that problem solving is one of the most important abilities to be honed in learning mathematics (Kristianti, N. K. H., Sudhita, I. W. R. S., & Riastini, P. N.). Öztürk et al (2020)

states that problem solving is the process of solving problems that are resolved by using information, skills, and also attitudes that are used when someone faces unfamiliar or unfamiliar situations. Sugiman (2009) states that problem-solving skills are not just the goal of learning mathematics but are even the heart of mathematics. This means, problem solving ability is a basic ability in learning mathematics.

Polya (1973) interprets problem solving as an attempt to find a way out of a difficulty in order to achieve a goal that is not so easy to achieve immediately. It appears that learning to solve problems is essentially learning to think or learning to reason, namely thinking or reasoning by applying previously acquired knowledge to solve new problems that have never been encountered (Purwanto, 2013). Through the process of solving problems, students can develop skills in critical thinking (Purwanto, 2013).

Polya (1973) states that there are four steps to the problem solving phase, namely analyzing and understanding the problem, designing and planning a solution, solving the problem, and re-checking all the steps taken. has been done (verifying a solution). Understanding the problem is of course not just reading, but also digesting the material presented and understanding what is going on. In other words understanding the problem/reading the problem is an activity of identifying what is asked to be solved and the facts given. The activity of planning, the problem solver finds the relationship between the given data (which is known) and the unknown (which is asked). If the relationship between the two is not immediately obtained, the problem solver can use auxiliary problems so that a solution plan is obtained (Baiduri, 2015). At this stage it is also related to what strategy will be used. Implementing the plan relates to checking each stage of the plan that was made before. Rechecking activities are related to the correctness/certainty of the solutions obtained (Baiduri, 2015).

As for research on the implementation of the Polya stages carried out by(Sariati, K., 2013) to improve learning achievement and student motivation, (Apryanti, H., Ismail, F., & Fitriani, Y., 2015) on solving math story problems(Nitya, I. G. E. P. D., Koyan, I. W., & Partadjaja, T. R. , 2013) to increase the activity and student learning outcomes, and (Masrurotullaily, Hobri, & Suharto., 2013) in analyzing financial mathematical problem solving.

Based on the explanation above, this time the researcher will present a study on the analysis of the problem-solving ability of polya stages in solving comparative material in mathematics courses. This study will describe students' problem-solving abilities at each stage of problem-solving abilities. It is hoped that this research can be used as a basis for providing lecturer assistance to students who experience problems in the process of solving mathematical problems.

B. Methods

This type of research is qualitative research using a descriptive approach. According to Arikunto (2010) Descriptive research is research that is intended to investigate circumstances, conditions, situations, events, activities, etc., and the results are presented in the form of a research report. The purpose of this study is to describe the ability to solve mathematical problems using polya stages in comparative material. The subjects in this study were students

of the Open University Elementary School Teacher Education Study Program Semester 2 of the Academic Year 2021/2022.

The subjects in this study were 15 students who would later be grouped based on the category of solving mathematical problems. The following is a category of students' mathematical problem solving abilities used by Hermawati et al (2021) that is:

Table 1. Categories of Mathematical Problem Solving Ability

Categories	Achievement Percentage
High	$75 < P \leq 100$
Medium	$60 < P \leq 75$
Low	$0 < P \leq 60$

The data obtained from all 15 students will be used, while for the interview stage two students will be taken in each category of mathematical problem solving abilities. This research was conducted in December 2022 - February 2023. To validate the data in this study, the triangulation method was used. Data collection techniques in this study used diagnostic tests and interviews.

Where the diagnostic test is in the form of a description test for the Mathematics course on comparative material. The expected data is in the form of students' work on a diagnostic test in the form of a description test of 2 questions along with the steps for solving them according to the Polya stage. The purpose of the diagnostic test is to determine students' problem-solving skills in solving math problems. The results of student answers to the diagnostic test questions were analyzed based on the assessment rubric. The rubric for assessing mathematical problem-solving abilities in this study was adapted from Mufarida's rubric (2008). This rubric can be seen in Table 2.

Table 2. Problem Solving Ability Assessment

Rated Aspect	Reaction to the problem (problem)	Score
Understanding	Do not write down/do not mention what is known and what is asked of the questions.	1
	Just write down/mention what is known.	2
	Write down/mention what is known and what is asked from the questions inaccurately.	3
	Write down/mention what is known and what is asked of the questions correctly.	4
Planning	Does not present a sequence of solution steps.	1
	Presents a sequence of solution steps, but the presented sequence of solutions is not accurate.	2
	Presents the correct sequence of solving steps, but leads to the wrong answer.	3
	Presenting the correct sequence of completion steps and leading to the correct answer.	4
Solving	There is no solution at all.	1
	There is a solution, but the procedure is unclear.	2
	Using certain correct procedures but incorrect answers.	3
	Using certain correct procedures and correct results.	4
Checking	Do not write checks and do not write conclusions.	1

Write conclusions without writing checks.	2
Just write checks without writing conclusions.	3
Write checks and conclusions.	4

Furthermore, for the data obtained through the interview method using interview guidelines. Interview guidelines are unstructured because researchers do not use guidelines that have been compiled in a complete and systematic way to collect data, but the guidelines used are only an outline of the problems to be asked (Sugiyono, 2016). The purpose of the interview was to clarify the results of the student's answers in accordance with the polya problem solving stages.

Data analysis techniques were carried out by data reduction, data presentation, conclusions and verification. In this study also the results of data analysis using a descriptive approach. Data reduction is done when taking the subject as data. The researcher gave a diagnostic test to determine the category of problem solving ability. Furthermore, the same data will be taken one of which is then conducted interviews with reduced subjects. If there is data that can provide information, then the data is used. Presentation of data is done with narrative text. Conclusions were drawn after the researchers triangulated the method between diagnostic tests and interviews. From the results of the conclusions, the results of problem solving abilities based on the polya stage will be obtained which are divided into high, medium and low categories.

C. Results and Discussion

This research was conducted on 15 students of the Open University Elementary School Teacher Education Study Program to determine students' problem solving abilities based on the Polya stage which were in the high, medium, and low categories. The following are categories of mathematical problem solving abilities obtained by students in completing mathematical problem solving ability tests in Table 3.

Table 3. Percentage of Students' Mathematical Problem Solving Ability

Categories	Number of Students	Percentage (%)
High	6	40
Medium	6	40
Low	3	20
Total	15	100

Based on table 3 data, out of a total of 15 students who were the subject of the study, there were 6 students who had high category problem solving abilities with a percentage of 40%, 6 students had moderate category problem solving abilities with a percentage of 40%, and 3 students had problem solving abilities. low category problems with a percentage of 20%. Therefore, from all research subjects it was found that students with low category mathematical problem solving abilities had the least percentage compared to the high and medium categories.

Furthermore, the results of the recapitulation of the results of the ability assessment of mathematical problems in comparative material for PGSD UT students can be seen in Table 4.

Table 4. Assessment of Mathematical Problem Solving Ability

No Question	Problem Solving															
	Understanding				Planning				Solving				Checking			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
1	7	5	1	2	5	3	7	0	6	5	1	3	5	4	3	3
2	6	4	5	0	6	4	2	3	6	5	4	0	5	6	1	3

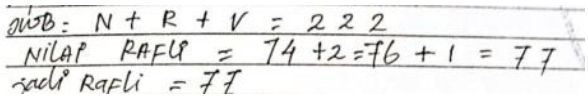
The description of each stage of solving mathematical problem solving is described as follows:

1. Understanding

The first step in solving a problem according to Polya is to understand the problem. In the first stage students are required to make a picture or illustration if possible, look for special cases, and try to understand the problem in a simple way. Furthermore, students are required to be able to write down/mention what is known and what is asked of the questions correctly. The following are the results of the Understanding stage analysis for each category of research subject.

a. Low Category

Based on the results of diagnostic tests and interviews, the results of student work in the low category at stage 1 (understanding) were obtained in Figure 1.



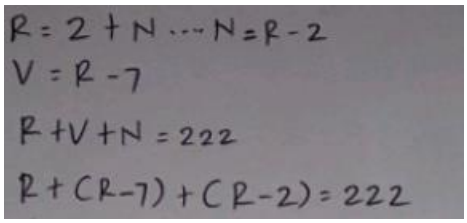
S31: "What is known is that Nadia (N), Rafli (R), and Vito (V)'s test scores immediately add up the result 222"

Figure 1. Results of Stage 1 Low Category Questions

Based on Figure 1, students are incomplete in writing down the information they know and are asked questions. This is also reinforced by the results of interviews where students can only determine the sum of the ages of the three students without defining one by one.

b. Medium Category

Based on the results of diagnostic tests and interviews, the results of student work in the medium category at stage 1 (understanding) were obtained in Figure 2.



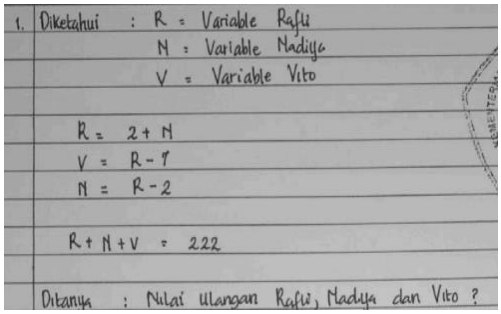
S21: "It is known that Rafli's score is 2 higher than Nadia and Vito's score is 7 lower than Rafli's. The sum of the three ages of Rafli, Vito and Nadia is 222."
P: “whereas what is being asked about?”
S21: “what is being asked is the grades of Rafli, Nadia and Vito.”

Figure 2. Work Results of Stage 1 Questions Medium Category

It can be seen from Figure 2 that students only wrote down what was known in the problem but did not write down exactly what was asked from the problem. However, during the interview students can explain what is asked in the questions.

c. High Category

Based on the results of diagnostic tests and interviews, the results of student work in the high category at stage 1 (understanding) were obtained in Figure 3.



S11: "known R variable Rafli, N variable Nadia, V variable Vito. R = 2 + N means that Rafli's score is 2 points higher than Nadia's. Vito's score is 7 points lower than Rafli's score and Nadia's score is 2 points lower than Rafli's score. Furthermore, the sum of Rafli, Nadia and Vito's scores is 222. What is being asked is each of their scores."

Figure 3. Work Results of Stage 1 Questions in the High Category

Based on Figure 3 students can write down or mention what is known and asked in the questions correctly and completely. This is also reinforced during interviews where students can explain what is known and asked questions.

From the results of the analysis above, it was found that the three categories had different stage 1 (Understanding) abilities, where the low category could not write down or mention what was known and asked about the questions, but for the medium and high categories students were able to write down or mention what was known. and asked questions.

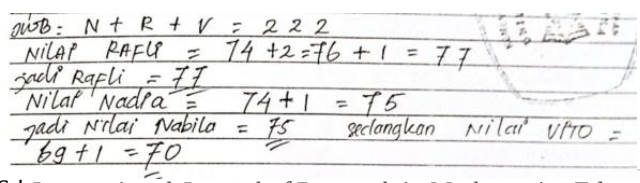
Based on the test answers, it was found that 12 students (80%) could understand the problem in question number 1, while for question no.2 there were 10 students (66.67%). Most students cannot understand the problem because students have not been able to identify the elements that are known in the problem and change the statement into a mathematical model. This is in line with Timutius et al (2018) which states that students who do not identify the necessary elements as known or asked mean that students do not understand the problem properly.

2. Planning

The second step of problem solving according to Polya is to plan a settlement. The designing and planning phase includes planning solutions systematically, and determining what to do, how to do it and the expected results. At this stage, 2 types of responses were found by students, namely students writing a settlement plan on the answer sheet and students not writing a settlement plan on the answer sheet (doing directly). The following are the results of the analysis of the Planning stage for each category of research subjects.

a. Low Category

Based on the results of diagnostic tests and interviews, the results of student work in the low category in stage 2 (planning) were obtained as follows:



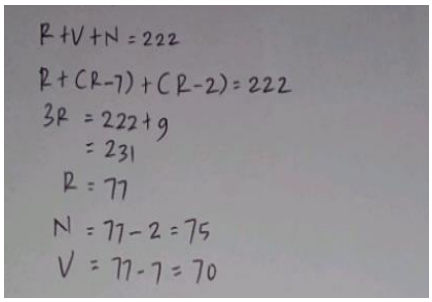
S31: "to first use the equation of the sum of the three values, then find the value of each."

Figure 4. Results of Stage 2 Low Category Questions

Based on Figure 4, it can be seen that students have been able to present a sequence of completion steps, but the sequences of completion presented are inaccurate and strengthened from the results of interviews where students cannot explain precisely.

b. Medium Category

Based on the results of diagnostic tests and interviews, the results of student work in the medium category in stage 2 (planning) were obtained in Figure 5.



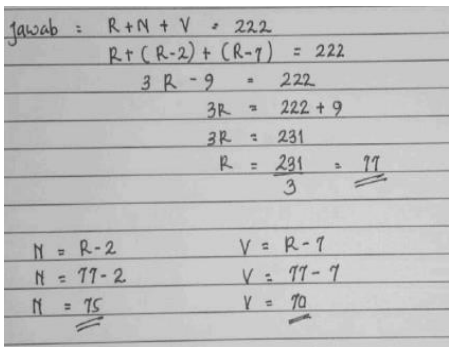
S21: “To solve this problem, use the equation for the sum of the three values, which is 222, then enter the Vito and Nadia equations to get Rafli's value. In the end, Nadia and Vito's scores will be obtained."

Figure 5. Work Results of Phase 2 Medium Category Questions

In Figure 5 it can be seen that students in the moderate category have been able to present the sequence of completion steps correctly, but lead to inaccurate answers because the completion steps are incomplete. Even though the results of the interviews showed that students were able to plan a settlement with the correct steps.

c. High Category

Based on the results of diagnostic tests and interviews, the results of student work in the high category in stage 2 (planning) were obtained as follows:



S11: "first use the equation of the sum of the three values R + N + V = 222. Then enter the equations N and V where N = R - 2 and V = R - 7 then the value of R or Rafli will be obtained. From the value of R = 77 included in the N and V equations, the Nadia and Vito values will be obtained.”

Figure 6. Work Results of Stage 2 Questions in the High Category

Based on Figure 6, students in the high category are able to present the sequence of completion steps correctly, completely and lead to the correct answer. This shows that students are able to make plans for the problems they face with reinforcement from the results of interviews where students can explain the settlement plan properly according to what is written.

From the results of the analysis above, it was found that the three categories had different stage 2 (Planning) capabilities, where the low category could not present the sequence of completion steps, the medium category could present the sequence of steps correctly but led to an incorrect answer, and the category height can present the correct, complete sequence of completion steps and lead to the correct answer.

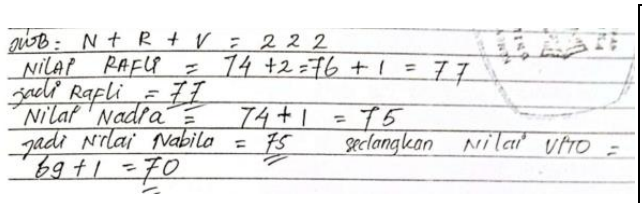
Based on the test answers, it was found that 8 students (53.33%) were able to correctly present the order of completion steps in question number 1, while for question no.2 there were 10 students (66.67%). Most students are able to present the order of completion correctly, but have not yet led to the correct answer.

3. Solving

The third stage is to find a solution to the problem. In the problem solving stage it is very dependent on the experience of students to be more creative in compiling a solution to a problem. Following are the results of the analysis of the Solving stage for each category of research subjects.

a. Low Category

Based on the results of diagnostic tests and interviews, the results of student work in the low category in stage 3 (solving) were obtained as follows:



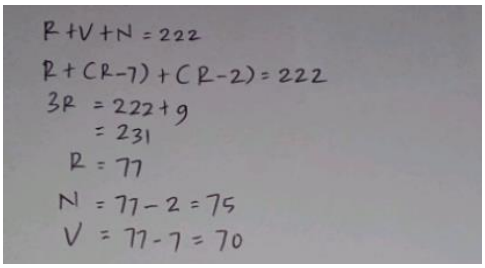
S31: "The sum of Nadia, Rafli and Vito's scores is 222. Then we get Rafli's score of 77 from 74 plus 2 and 1. Then Nadia's score is 75 from 74 plus 1 while Vito's score is 69 plus 1 to 70."

Figure 7. Results of Stage 3 Low Category Questions

Based on Figure 7 it appears that students in the low category provide solutions but the procedures or steps are not clear so that the answers given are also wrong. Students do not understand what steps to solve the problem.

b. Medium Category

Based on the results of the diagnostic tests and interviews, the results of student work in the medium category were obtained in stage 3 (solving) as follows:



S21: "first add up R + V + N = 222, then enter the equations V and N so you get the Rafli value of 77 then enter it into the equation to get the values of Nadia 75 and Vito 70."

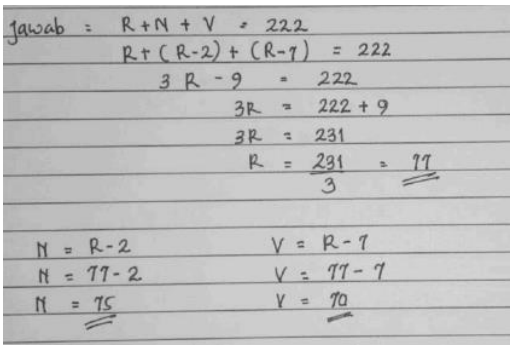
Figure 8. Work Results of Phase 3 Medium Category Questions

Figure 8 shows that students are able to answer questions with the right flow and stages so as to provide the correct final result according to the plan in the previous step. This was also

reinforced by the results of the interviews which explained the settlement procedures that were appropriate to the problem.

c. High Category

Based on the results of diagnostic tests and interviews, the results of student work in the low category in stage 3 (solving) were obtained in Figure 9.



S11: "first use the equation of the sum of the three values R + N + V = 222. Then enter the equations N and V where N = R - 2 and V = R - 7 then calculate the value R = 77. Enter the value R = 77 in the equation N and V so that each obtained 75 and 70."

Figure 9. Work Results of Stage 3 Questions in the High Category

In Figure 9 it appears that students in the high category are able to solve questions in a coherent and correct manner so that they get the correct final grade according to what was planned in the previous step.

Based on the analysis, it was found that the three categories had different stage 3 (Solving) abilities, where the low category provided solutions but the procedure or rarity was not clear so that the answers given were also wrong, the medium and high categories were able to answer questions with the right flow and stages so as to provide correct final result as planned in the previous step.

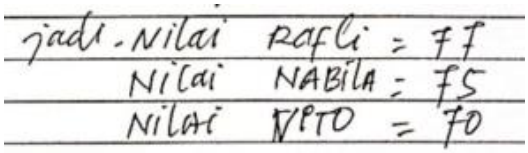
Based on the test answers, it was found that 12 students (80%) were able to answer the questions with the correct flow and steps so as to provide the correct final results according to plan in question number 1, while for question no.2 there were 10 students (66.67%). Most students are able to find strategies or solutions using the right procedures in solving problems so that they get the right answers. This is in line with Aspiandi et al (2020) which states that students with good problem-solving skills can find the right strategy or solution to solve problems.

4. Checking

The last stage is examining the solution which consists of activities using specific examinations of each information and completion steps and using general inspections to find out the problem in general and its development. In addition, at this stage it is equipped with writing conclusions on solving the problem. Following are the results of the Checking stage analysis for each category of research subjects.

a. Low Category

Based on the results of diagnostic tests and interviews, the results of student work in the low category at stage 4 (checking) were obtained as follows:



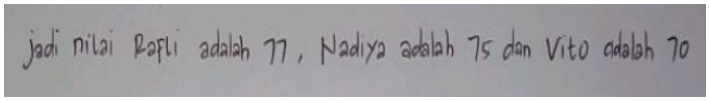
P: “After getting the answer, did you check your answer again?
S31: "check again ma'am but just don't check that it's just a rudimentary one"

Figure 10. Low Category Stage 4 Problem Work Results

Figure 10 shows that students have checked their answers again, but because they do not understand the steps for solving them, the answers given are not correct. However, students write conclusions from answers even though the answers given are not correct.

b. Medium Category

Based on the results of diagnostic tests and interviews, the results of student work in the medium category at stage 4 (checking) were obtained as follows:



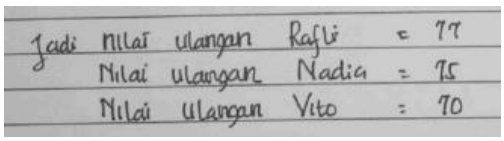
P: "After getting the answers, did you check the answers again?"
S21: "Yes ma'am, I checked again from the beginning regarding the equations and calculations."
P: "to strengthen the answer what to do?"
S21: "I will write down the answers again in conclusion for each value of Rafli, Nadia and Vito."

Figure 11. Work Results of Phase 4 Medium Category Questions

Based on Figure 11 it appears that students in the middle category did not write down the re-checking stage but during the interview it was conveyed that the student checked his answers regarding equations and calculations. In addition, students also write conclusions about answers with the right results.

c. High Category

Based on the results of diagnostic tests and interviews, the results of student work in the high category at stage 4 (checking) were obtained as follows:



P: "After finishing work, the answers are checked again?"
S11: "Yes, I checked again from the beginning to the calculations, then I gave a conclusion for each value from Rafli, Nadia and Vito."

Figure 12. Work Results of Stage 4 Questions in the High Category

It can be seen from Figure 12 that students in the category did not write down the re-checking stage but during the interview it was conveyed that the student checked the steps and calculations. In addition, students also wrote a summary of the answers with the correct results.

Based on the analysis, it was found that the three categories had different stage 4 (Checking) abilities, where the low category gave but the conclusions that were written were not correct, the medium and high categories wrote the conclusions of the answers with the right results without writing down the checks.

Based on the test answers, it was found that 9 students (60%) were able to write a conclusion with the right results on question number 1, while for question no.2 there were 11 students (73.33%). Most of the students wrote the conclusion of the answers with the right results without writing checks.

Based on the results of the analysis above, students who fall into the high category have good problem-solving skills according to the Polya stage. This is in line with the results of Christina & Adirakasiwi's research (2021) which states that students with high problem-solving abilities are able to use the four stages of Polya well.

According to Christina & Adirakasiwi (2021) in their research it showed students with low mathematical problem solving abilities were more dominant than students with high and moderate mathematical problem solving abilities. The results of this study were different from this study, where as many as 12 students (80%) who were in the high and medium categories had good solving skills according to the Polya stage.

D. Conclusion

Based on the results of the analysis and discussion of this research, it can be concluded that problem solving abilities according to Polya vary at each stage in each category. For students in the low category, they are incomplete in writing down the information they know and are asked about the questions, the sequence of solutions presented is inaccurate, the procedures or steps are written but they are not correct, and the answers are checked again but the conclusions written are not correct.

Whereas students in the moderate category have the ability to solve problems, namely writing what is known in the problem but not writing down what is asked of the problem, presenting the correct sequence of steps for solving the problem, but leading to wrong answers using certain procedures or steps that are correct and the results are correct. , and write down the conclusion of the answer with the right results without writing a check.

For the high category, according to Polya, the ability to solve problems is writing/mentioning what is known and what is asked of the questions correctly, presenting the correct sequence of steps for solving the problem, complete and leading to the right answer, using the right steps or procedures and getting results. correct, and write conclusions without writing checks.

Acknowledgement

In this research, I would like to thank the Open University Elementary School Teacher Education Study Program (PGSD) for providing the opportunity to conduct research, PGSD students who have assisted in obtaining research data, Nahdlatul Ulama University Purwokerto as the home base where I develop my career as a lecturer, husband and both. my son who always supports me and gives me the opportunity to grow.

References

Abdurrahman, M. (2003). *Pendidikan Bagi Anak Berkesulitan Belajar.* Jakarta: PT Rineka Cipta.

Apryanti, H., Ismail, F., & Fitriani, Y. (2015). Penerapan Teknik Pemecahan Masalah Model Polya Terhadap Kemampuan Menyelesaikan Soal Cerita Matematika Pada Siswa Kelas VIII SMP Negeri 46 Palembang. *JPM RAFA, 1*(2), 224 - 243.

Arikunto, S. (2010). *Prosedur Penelitian Suatu Pendekatan Praktik.* Jakarta: Rineka Cipta.

Aspiandi, H., R, Z., & Nursangji, A. (2020). Deskripsi Kemampuan Pemecahan Masalah Matematis Siswa Pada Materi Bangun Datar Di SMP. *Program Studi Pendidikan Matematika FKIP Untan*, 1 - 8.

Baiduri. (2015). Pengaruh Tahapan Polya Dalam Pemecahan Masalah Terhadap Ketuntasan Belajar Geometri Siswa Sekolah Menengah Pertama. *Jurnal Pendidikan Matematika, 6*(1), 41 - 48.

Chang, Y. L., & Huang, Y. I. (2014). A Study of Improving Eighth Graders' Learning Deficiency in Algebra by Applying a Realistic Context Instructional Design. *International Education Studies, 7*(1), 1 - 8.

Christina, E. N., & Adirakasiwi, A.G. (2021). Analisis Kemampuan Pemecahan Masalah Tahapan Polya dalam Menyelesaikan Persamaan dan Pertidaksamaan Linear Satu Variabel. *JPMI: Jurnal Pembelajaran Matematika Inovatif, 4*(2), 405 - 424.

Christina, E.N., & Adirakasiwi, A.G. (2021). Analisis Kemampuan Pemecahan Masalah Tahapan Polya Dalam Menyelesaikan Persamaan dan Pertidaksamaan Linear Satu Variabel. *JPMI: Jurnal Pembelajaran Matematika Inovatif, 4*(2), 405 - 424.

Hermawati, Jumroh, & Sari, E. F. P. . (2021). Analisis Kemampuan Pemecahan Masalah Matematik Siswa SMP pada Materi Kubus dan Balok. . *Mosharafa: Jurnal Pendidikan Matematika, 10*(1), 141 - 152.

Kristianti, N. K. H., Sudhita, I. W. R. S., & Riastini, P. N. . (2013). Pengaruh Strategi REACT Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas IV SD Gugus XIV Kecamatan Buleleng. *Mimbar PGSD, 1*(1), 1 - 9.

Masrurotullaily, Hobri, & Suharto. (2013). Analisis Kemampuan Pemecahan Masalah Matematika Keuangan Berdasarkan Model Polya Siswa Smk Negeri 6 Jember. *Kadikma, 4*(2), 129 - 138.

Mufarida, A. (2008). *Kemampuan Siswa dalam Memecahkan Masalah Matematika Berbentuk Soal Terbuka Pada Materi Jajargenjang Di Kelas VII-C SMP Negeri 1 Bangsal Mojokerto.* Surabaya: UNESA.

Nitya, I. G. E. P. D., Koyan, I. W., & Partadjaja, T. R. . (2013). Penerapan Model Polya Untuk Meningkatkan Aktivitas Dan Hasil Belajar Matematika Dalam Menyelesaikan Soal Cerita Pada Siswa Kelas V SD No . 2 Pemaron. *Mimbar PGSD UNDIKSHA, 1*(1), 1 - 10. doi:https://doi.org/10.23887/jjpgsd.v1i1.1454

Öztürk, M., Akkan, Y., & Kaplan, A. (2020). Reading comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey. *International Journal of Mathematical Education in Science and Technology*, 1042 - 1058.

doi:https://ui.adsabs.harvard.edu/link_gateway/2020IJMES..51.1042O/doi:10.1080/0020739X.2019.1648893

Polya, G. (1973). *How to Solve It: A New Aspect of Mathematical Method (Second Edition).* New Jersey: Princeton University Press.

Purwanto. (2013). *Strategi Pembelajaran Bidang Studi Geografi.* Malang: Universitas Negeri Malang (UM Press).

Sariati, K. (2013). Penggunaan Strategi Heuristik Model Polya pada Pembelajaran Pemecahan Masalah Matematika Untuk Meningkatkan Prestasi Belajar Siswa Kelas VIII B SMP Negeri 40 Purworejo Tahun Pelajaran 2011/2012. *Ekuivalen, 1*(1), 28 - 34.

Sugiman. (2009). *Mathematical Problem Solving in Mathematics Realistic.* Medan: Program Studi Pendidikan PPs UNIMED.

Sugiyono. (2016). *Metode penelitian pendidikan (pendekatan kuantitatif, kualitatif, dan R&D).* Bandung: Alfabeta.

Timutius, F., Apriliani, N. R., & Bernard, M. (2018). Analisis Kesalahan Siswa Kelas IX-G Di Smp Negeri 3 Cimahi Dalam Menyelesaikan Soal Pemecahan Masalah Matematik Pada Materi Lingkaran. *JPMI: Jurnal Pembelajaran Matematika Inovatif, 1*(3), 305 - 312.

This page has been intentionally left blank.