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# SYSTEMATIC LITERATURE REVIEW: MATHEMATICAL COMMUNICATION ABILITY THROUGH QUANTUM LEARNING MODEL BASED ON SELF EFFICACY

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**ABSTRACT**

Mathematical communication skills are fundamental skills in learning mathematics. Mathematical communication skills are also linked to self-efficacy. This study aimed to determine the improvement and relationship of students' mathematical communication skills using Quantum Learning and self-efficacy. This study used the Systematic Literature Review approach with the PRISMA method. The electronic literature search source used is Google Scholar through Publish or Perish 8, which collects 994 articles, using national and international articles published from 2018-2023, indexed by Sinta 1-4 and indexed by Scopus, categorized as proceedings and journal articles, has full access and is classified as a field of mathematics education. The results showed that self-efficacy affects mathematical communication skills and Quantum learning models, and there is a relationship between self-efficacy and mathematical communication skills with Quantum learning models.



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## 1. INTRODUCTION

Mathematics is a worldwide field of study that serves as the basis for today's technological advancements. In addition, mathematics is an important component of many disciplines and can aid in the development of critical thinking skills(Sarini, 2019).

Mathematics is a vital topic that can help people solve challenges in life(Hendri Prayogi, 2019). Mathematics is a scientific discipline that investigates the relationship between ideas and abstracts (Gökalp, 2020; Hermawan & Andrianto, 2018). This means that mathematics is a subject that thinks with of course requires logical thinking. Learning maths is more than just memorizing facts; It's also about understanding the process and tracking it when it's done. For this reason, mathematics needs to be taught from elementary school for them to succeed.

In accordance with Law no. 22 of 2006, learning objectives include: 1) using ideas correctly and appropriately in solving problems and understanding the relationship between concepts, as well as understanding the relationship between concepts. 2) Use mathematics to gather evidence, 3) solve problems by understanding them, design mathematical solutions, implement comprehensive solutions, and interpret results 4) Use symbols, tables, images, or other media to explain ideas that can help understand problems or challenges 5) realize the importance of mathematics in their lives, have curiosity, attention, and are attracted to master it, and are persistent and firm with their ability to solve the problem(Adetia & Adirakasiwi, 2022).

Students' abilities when learning mathematics include the ability to solve problems, make decisions, communicate, and solve problems(Sopian & Sabandar, 2018). When learning math, students must be able to communicate effectively. Communication is a process by which a person sends carefully selected information so that the recipient can understand the significance of the information (Luritawaty, 2019; Maulana & Sritresna, 2021). In the context of education, communication is one of the insurmountable obstacles(Syah & Sofyan, 2021). Because, in the field of education, information is disseminated through knowledge and understanding possessed by both teachers and students. When the process goes well, people's trust grows(Sulastri & Sofyan, 2022).

But in fact, mathematics education in Indonesia is still faced with many problems, one of which is the low mathematical communication skills of students. This ability is important for gaining a better understanding in solving mathematical problems, and also for improving students' social and cognitive skills. Therefore, it is necessary to improve students' mathematical communication skills, this aims to make students able to understand mathematics learning better.

Communication is the first step in understanding a subject(Widayanti & Anggraeni, 2019). Therefore, communication with peers is very important for learning mathematics. This shows that communication is important to develop, especially in learning(Luritawaty, 2019). The ability to communicate mathematically is the ability to understand and communicate designs, truths, and ideas in mathematics in a way that others can understand(Sopian & Sabandar, 2018). In addition to its ability to be understood by others, communication is also important in evaluating student learning outcomes. In the context of mathematics, students can evaluate their learning outcomes through interaction with teachers or peers. This allows students to identify and improve their learning outcomes(Sulastri & Sofyan, 2022). This means mathematical communication has important implications for mathematics education because it allows students to understand, write down, and develop ideas or concepts systematically and consistently(Fauziah et al., 2018).

In the field of mathematical communication, it was found that student’s ability to communicate mathematically was still lacking(Purnamasari & Afriansyah, 2021; Yanti & Novitasari, 2021). This implies that mathematical communication capacity among students is deteriorating(Nuraeni, 2018). Previous results were also influenced by the OECD PISA survey conducted in 2018. Indonesia has 379 senators and is ranked 73rd out of 79 countries. This estimate is based on PISA results from 2015 which showed an increase of 63 points from 76, with an average score of 386. In addition, according to the analysis of IEA TIMSS

data in 2015, Indonesia ranked 45th out of 50 countries. For this reason, understanding mathematics education is very important to understand mathematics communication skills in the classroom.

Based on the description above, students need to have a good mastery of mathematical communication skills, but in fact the level of students' mathematical communication skills is still relatively low. This is reinforced by previous research that has proven that students' mathematical communication skills are still relatively low, such as research conducted by Nufus (2017) which states that students are less able to read written mathematical representations, write symbols and precise mathematical notations and make mathematical models of the story problems presented. The level of an error made by students related to answering questions containing indicators of mathematical communication skills will vary according to the level of intelligence, in this case, represented by the level of school level. In fact, the low ability of these students is also influenced by the level of activity during their learning. Furthermore, research conducted by Nopiyani et al., (2018) shows that students' communication skills and responses to math problems are still relatively low. In addition, the results of research conducted by (Azmi, 2017) show that mathematical communication is not an easy thing because students' thought processes cannot be directly captured by the five senses but must be trained to communicate mathematically both orally and in writing and research still finds low mathematical communication skills of students, especially mathematical written communication.

Reinforced by the results of research conducted by Zaditania & Ruli, (2022) showed that the 4 points of mathematical communication questions given received results for question points number 2 and 4 included in the low category with a percentage of ≤ 33%, question item number 1 included the medium category with a percentage of >33% while question item number 3 was included in the high category with a percentage of >66%. This concludes that the mateamtic communication skills of junior high school students are still relatively low, where there are 2 out of 4 questions that are still in the low category. One of the causes of low mathematical communication skills is that the understanding of concepts in the set material is still fairly lacking, resulting in misunderstanding of what is asked on the problem.

Based on existing problems, a solution is needed to deal with this. The solution that researchers use in overcoming students' mathematical communication skills is to use the Quantum Learning learning model. Quantum Learning is a new approach and theory of learning that is evolving in schools and companies for all types of individuals and for all reasons(Rahayu et al., 2016) Quantum Learning features a systematic learning framework that includes: growth, experience, name, demonstrate, repeat, and celebrate(Dewi & Nuraeni, 2022). In addition, Quantum education can provide a fun learning environment for students by providing information on efficient and effective material handling(M. P. Ningsih et al., 2021). Learning is successful and meaningful when students connect with learning resources such as content, space, formed environments, and engaging learning activities accompanied by music.

In addition to the model used, to achieve maximum results in learning, a motivation is needed to build students' self-confidence or self-efficacy in following learning. Providing motivation in learning can be done by integrating with existing learning activities during the learning process. According to Nizham et al., (2017) Self efficacy is an individual's assessment of his ability to plan and take action to achieve goals. In addition, according to Malinauskas (2017) suggests that self-efficacy is an individual's confidence in his ability to complete certain tasks. This is in line with the opinion of Saptika et al., (2018) that students' thinking or mindset towards their abilities can affect their success in learning.

However, if students have a negative mindset, such as believing that abilities cannot be developed or that success is determined only by innate intelligence, then they may more easily feel discouraged or avoid challenges for fear of failure. These thoughts must also be repetitive and entrenched in students to have a significant influence on their success. This means that students must consistently practice and reinforce positive thinking about their abilities in order to become a habit and part of their broader mindset. However, students' mindset is not the only factor influencing their success. Other factors such as learning environment, social support, motivation, and opportunity can also play an important role in helping students achieve their academic and personal success.

Based on the description above, researchers hope that students are able to understand mathematics learning by mastering mathematical communication skills using quantum learning models and increase student self-efficacy.

### 1.1. Mathematical Communication Skills

Communication is the transfer of messages from one person to another to transmit information, ideas, or feelings(Astuti & Leonard, 2015). In communication, feedback is very important in the communication process because it shows whether or not the message was received by the intended recipient and how the message was received. If needed, feedback can assist the sender of the message in correcting or correcting the message sent. As a result, feedback is an important component of a good communication process. In mathematics learning there is mathematical communication.

Mathematical communication is the capacity of students to express mathematical proposals or designs, both orally and in writing, including the process of collecting, explaining, and drawing conclusions(Swasti et al., 2020). Mathematical communication skills can be examined from two perspectives: writing and speaking(R. M. Ningsih & Awalludin, 2021). Students' written mathematical communication can be demonstrated when they reveal their mathematical concepts to instructors or friends in group discussions. Simultaneously, communication skills are displayed when students answer problems using models, tables, graphs, or other mathematical symbols. To make mathematical communication skills important for students, almost all mathematical topics require the use of models, tables, diagrams, or other symbols(Asih et al., 2019).

Mathematical communication skills include: (1) describing mathematical ideas clearly and easily accessible; (2) making definitions of mathematical concepts and developing generalizations using discovery methods. (3) use words, symbols, concepts, or mathematical models to describe real-world shapes, diagrams, or events; (4) explain or clarify mathematical ideas, situations, or relationships in everyday language, orally or in writing; (5) interpret, explain, and update mathematical presentations; and (6) understand and use mathematical notation appropriately and precisely (Surya & Riska Rahayu, 2014)

Some indications of communication skills include the following: (1) associating real-world objects with drawings, diagrams, and mathematical concepts; (2) expressing mathematical concepts, statuses, and bonds orally or in writing using real-world mathematical objects, illustrations, diagrams, and symbols; (3) communicate everyday situations with mathematical language or representations (4) participate in discussions, give presentations, and write about mathematics; (5) reading perception of written mathematical representations; (6) create conjectures, formulate pretexts, and elaborate definitions and abstractions in mathematics; (7) describe and propose discussions on the mathematics topics studied(Astuti & Leonard, 2015).

There are many strategies that can optimize students' mathematical communication skills, including familiarizing them to present their ideas, listen, speak, read, and write(Yang

et al., 2016). Furthermore, teachers can request that students express their opinions orally or in writing. It helps students strengthen their ability to communicate and write numerically and allows instructors in understanding students' knowledge of the math topics taught

### 1.2. Self-Efficacy

Self-efficacy is a key aspect of a person's ability to complete various academic obligations at a certain level(A. A. Putri et al., 2022). Self-efficacy has an impact on academic motivation and learning motivation, as well as learning resilience(Masitoh & Fitriyani, 2018). Self-efficacy is defined as a person's confidence in his or her capacity to perform activities, achieve goals, and overcome problems(Nahdi, 2018). Self-efficacy is an evaluation of oneself whether a particular task can be completed according to one's needs or not. Self-efficacy refers to a person's belief in his or her ability to cope with a job. A person with high self-efficacy can (1) reduce stress, (2) accept responsibility for his success, (3) manage risk, and (4) recognize his or her potential. and weakness, (5) able to socialize with others, (6) persistent and unyielding

### 1.3. Quantum Learning

Quantum Learning is a new way of learning and philosophy for individuals and students in schools and businesses(Dewi & Nuraeni, 2022). Quantum learning is learning used in a comfortable learning environment where learning ability and communication skills can be improved(Sultan & Hajerina, 2020). The Quantum Learning model consists of guidance, mentoring, advice, and an overall learning process that can improve knowledge and memory while making learning satisfying and enjoyable(Anisa et al., 2019)

## 2. METHOD

### 2.1. Research Design

A systematic literature review (SLR) by using the Preferred Reporting Items for Systematic Reviews and Meta-analyses method or can be called the PRISMA method, this method is carried out systematically by following the research stages correctly. SLR is a strategy for identifying, assessing, evaluating, and interpreting previous research on a subject(Triandini et al., 2019). SLR research seeks to collect, analyze, and make conclusions from all research findings relevant to the research problem(Lame, 2019) The following stages are included in a systematic literature search: 1) asking questions to expand on previous research; 2) selection of criteria depending on the subject of study; 3) search related journals; 4) selecting relevant studies; and 5) whether the material is indexed with syntax or not(Fianingrum et al., 2023)

### 2.2. Literature Search Resources

The source of electronic literature search used is, Google Scholar through Publish or Perish 8 which collected 994 articles, using national and international articles published from 2018-2023, indexed by Sinta 1-4 and indexed by Scopus, categorized as proceedings and journal articles, has full access, and is categorized as a field of mathematics education. The keywords used are "Mathematical communication skills, self efficacy, and Quantum Learning Models". The following is an image attachment of literature search sources using google scholar through Publish or Perish 8 :

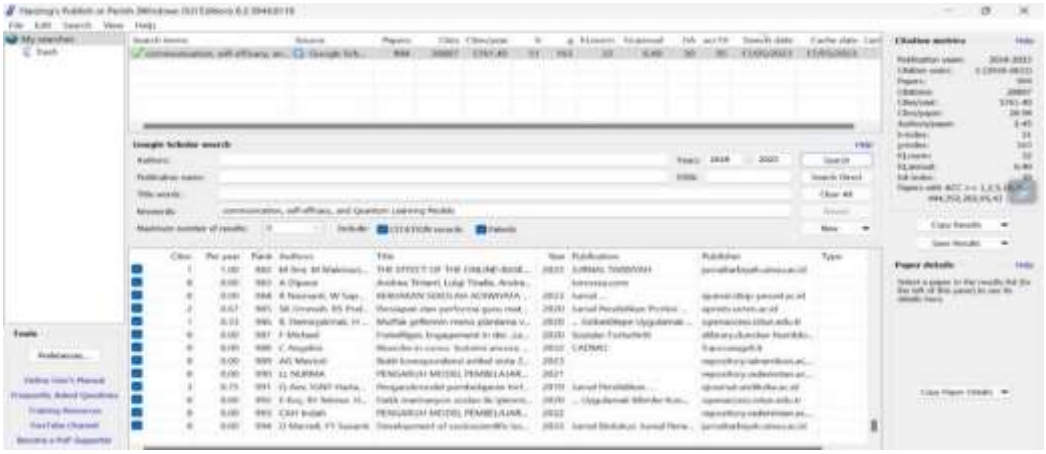

**Figure 1.** Google Scholar sourced Keyword Search using Publish or Perish 8

### 2.3. PRISMA Procedure

The literature study used in this study was 994 articles with year filtering starting from 2018-2023 and selection of titles from writing problems as many as 151 articles and carried out stage two selection according to the model that is often used, which is as many as 21 articles. Each literature study consists of journals that are relevant to the discussion of the problem. The selection process can be seen in Figure 2 :

### 2.4. Systematic Review Process

This process can be seen in Table 1 Explanation of Preparing Prtokol Review

**Table 1.** Explanation of the preparation of the Review stage

| No | Process | Information |
|---|---|---|
| 1 | Data Search | Data Search in this study refers to Google Scholar which is official and uses keywords that are adjusted to the research title and abstract or can be adjusted to research questions that have been made previously |
| 2 | Data Skrinning | This process includes filtering or selecting data (research articles or journals) tailored to the topic or title, abstract and keywords of the research problem. |
| 3 | Data Quality Assessment (feasibility) | This process is based on data (research articles or journals) with full text that meet the inclusion and exclusion criteria shown in Table 2. |
| 4 | Data Search Results | All data (research articles or journals) that meet all requirements and criteria will be further analyzed |

**Table 2.** Criteria *Inclusion* and *Exclusion*

| Criteria | Inclusion | Exclusion |
|---|---|---|
| Types of literature studies | Journal/article | Blog, e-Book, Citation |
| Years | 2018-2023 | <2018 |
| Field | Mathematics Education | Non Mathematics Education |

## 3. RESULTS AND DISCUSSION

### 3.1. Results

The screening stage involves two steps: choosing literature works based on titles taken into consideration (n = 151) and based on the most popular learning model (n = 21) that is pertinent to the discussion of the topic. This phase is depicted in Figure 2

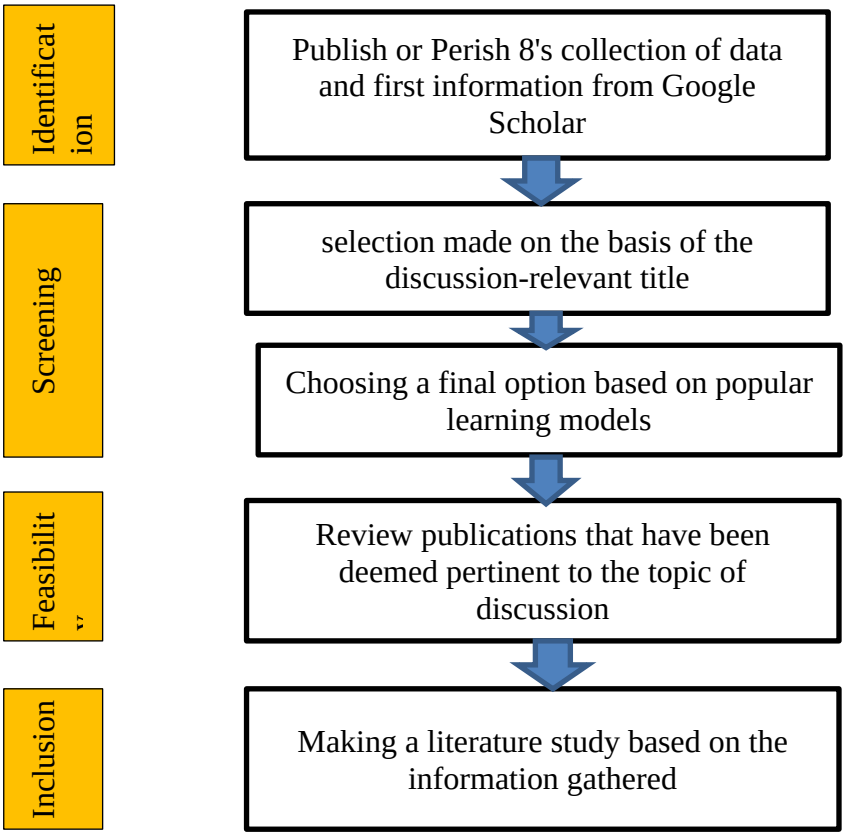


**Figure 2**. Prisma Flow Diagram.

The research data presented in this article is the result of journal research related to mathematical communication skills, self-efficacy, and Quantum Learning as many as 21 research documents in the 2018-2023 period. The number of published articles is presented in the figure below :

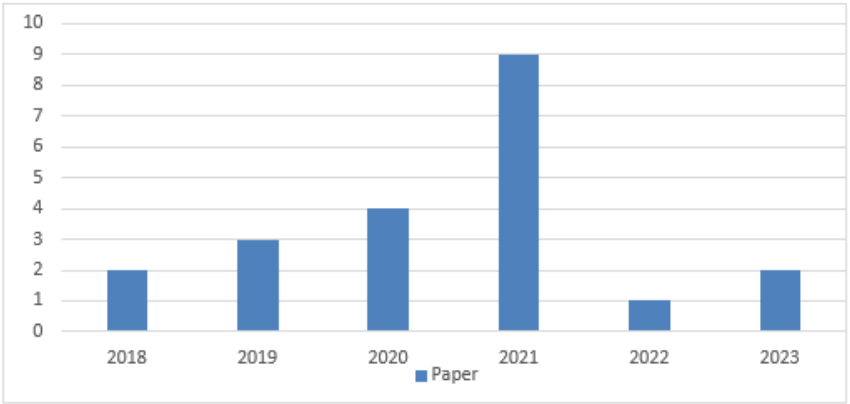


**Figure 3.** Total articles on mathematical communication skills reviewed self-efficacy with quantum learning in mathematics in 2018-2023 (n=21)

The number of papers per year is presented in Figure 3. wherein In 2018, there were 2 articles; In 2019, there are 3 articles; In 2020, there were 4 articles; In 2021, there are 9 articles; In 2022, there is 1 article; In 2023, there will be 2 article.

### 3.2. Discussion

The selected articles will be analyzed to determine the improvement and relationship of mathematical communication skills in terms of self-efficacy using quantum learning, as presented in Table 3 below :

**Table 3**. Journals that have been selected

| No | Name and Year | Journal Name | Research Results |
|---|---|---|---|
| 1 | Siagian, (2021) | Basicedu Journal | Quantum learning and jigsaw development can improve math learning outcomes. A key finding of the study is that education can boost students' creativity. For example, using constructivist learning theory helps students generate new knowledge and understand new ideas |
| 2 | Indah Hafizhah et al., (2022) | Journal of Social Research, Humanities, and Education | The results of this study show that learning mathematics is more successful as the number of students increases, so they think more critically, forward, and passionately. understand the mathematical principles taught |
| 3 | Suji et al., (2023) | Journal of Sigma Learning and Mathematics (JPMS) | Students who employ the REACT technique have stronger mathematics communication abilities and self-efficacy than those who use traditional learning models. Students who used the REACT strategy had higher self-efficacy and mathematics communication skills than those who used traditional learning methods. |
| 4 | Yati et al., (2019) | Journal of Didactic Mathematics | According to this study, students' mathematical communication abilities are strongly influenced by the employment of constructivism and self-efficacy approaches, and there is no relationship between these skills and self-efficacy when utilizing the constructivism learning strategy. |
| 5 | Falco & Summers, (2019) | Journal of Career Development | The study's findings highlight the need for interventions in counseling that may be effective in improving STEM self-efficacy in older students. |
| 6 | Supriyati et al., (2021) | Journal of Mathematics Education Innovation (JIPM) | High self-efficacy students are able to communicate their mathematical reasoning in order to discover the best answer to a challenge. In converting mathematical ideas into mathematical symbols and models, they seem strong and confident. Weak pupils |

| | | | |
|---|---|---|---|
| | | | frequently have difficulty articulating mathematical concepts and resolving issues. |
| 7 | Syafina & Pujiastuti, (2020) | Advanced Journal | Based on the research findings, the level of mathematical communication skills of mathematics students when completing mathematical tasks using SPLDV material can be summarized as follows: very high performers score four mathematical communication indicators, high performers score three, high performers score two, and very weak players do not score. In SPLDV statistics, the average proportion of pupils with communication skills is 45%. |
| 8 | D. K. Putri & Rochmad, (2021) | PRISMA, Proceedings of the National Seminar on Mathematics | Subjects with high learning independence can answer three questions posed by completing six predetermined indicators of mathematical communication skills; subjects with moderate learning independence have different achievement indicators, namely subjects can meet five specified indicators of mathematical communication ability; And subjects with low learning independence had no achievement indicators. Underperforming can resolve two indications of mathematical communication skills. |
| 9 | Viki & Handayani (2020) | Transformation : Journal of Mathematics and Mathematics Education | In addition to being influenced by other factors, the mathematics communication skill of vocational students is affected by self-efficacy to the extent of 37.69%. Due to their low self-efficacy, SMKN 34 Jakarta students also have poor mathematics communication abilities. Because of the correlation between student self-efficacy and growth in mathematical communication abilities |
| 10 | Masitoh & Fitriyani, (2018) | Malikussaleh Journal of Mathematics Learning (MJML) | (1) PBL is used in learning by more than 85% of students, with cycle I reaching 97.368% and cycle II reaching 96.491%. (2) At the end of the first semester, 60% of students passed the performance exam with an average score of 68.46. This score increased to 77.14% of students who passed the proficiency exam in Cycle II, with an average of 77.86. (3) The students' mathematical self-efficacy forecast was maintained at an average of 89.77 after the period I. This finding was supported by conclusions in Cycle II when students' mathematical self-efficacy was high (average 93.31). |

| | | | |
|---|---|---|---|
| 11 | Nurhayati & Asikin (2021) | IJoIS: Indonesian Journal of Islamic Studies | The relevance of mathematical communication skills in mathematics learning, especially in problem-solving. This is done so that academics can take advantage of the findings of this research to conduct further research to improve mathematical communication skills related to self-efficacy and learning models to obtain the greatest prospective research results. Learning mathematical communication skills is not only applied in high school but also in elementary school and college. |
| 12 | Emiliana (2019) | Jurnal Prodi Pendidikan Matematika (JPPM) | (1) The average communication ability and mathematical problem-solving ability was 42.85 on the failure criterion and 50.89 on the poor criterion before using quantum learning models on bivariate linear equation system materials; (2) After using quantum learning models on materials involving bivariate linear equation systems, the average communication ability and mathematical problem-solving ability were 67.55 with sufficient criteria and 63.39 with sufficient criteria. |
| 13 | Noperlis & Neviyarni (2023) | Eductum: Jurnal Literasi Pendidikan | The Quantum Learning learning method is useful for improving student learning outcomes. Students can be active and creative and absorb the topics taught using this method. |
| 14 | Maulana & Sritresna, (2021) | FARABI: Journal of Mathematics and Mathematics Education | Mathematical communication abilities and self-efficiency among pupils are related. For mastering mathematical communication skills, students with high self-efficacy perform better than those with moderate and low self-efficacy. |
| 15 | Imanuel & Lambertus, (2021) | Journal of Mathematics Education Research | The Pearson correlation coefficient of 0.716 indicates a strong positive association between self-efficacy and mathematical communication abilities, and the coefficient of determination for this relationship is 0.512, or 51.2%. Therefore, there is a 51.2% substantial correlation between the independent variable self-efficacy and the dependent variable bound to mathematical communication. with the 2-tailed sig. = 0.00 0.05 |
| 16 | Zaharah et al., (2021) | Journal of Scholar : Journal of Mathematics Education | On the basis of the N-Gain Test, a score of 0.51 was obtained on the medium criterion, and on the basis of the dependent t test (Paired Sample t Test), a significance value (2-tailed) |

| | | | |
|---|---|---|---|
| | | | was obtained, it was found that students in the medium group had improved their mathematical communication skills. 0.000 0.05 denotes a considerable change in students' mathematical communication abilities between learning mathematics with multimedia quantum learning and without it. Conclusion: Multimedia mathematics learning is effective and can help students' ability to communicate mathematically. |
| 17 | Pramudya et al. (2020) | Journal of Serunai Mathematics | Students in grade X at SMK Negeri 1 Stabat for the 2019–2020 academic year have improved their mathematics communication skills as a result of employing the quantum learning technique and teaching aids. |
| 18 | Simamora (2018) | Journal of Mathematics and Applied Education | The employment of quantum learning models versus conventional models in the Relations and Functions material in Class VIII SMP Negeri 2 Pematangiantar T.A 2017/2018 has a substantial impact on students' ability to communicate mathematically. The learning of the Quantum Learning model is more effectively used than the Conventional model in grade VIII SMP Negeri 2 Pematangsintar T.A 2017/2018, as evidenced by the fact that the average score of the Quantum Learning group is greater than the average score of the Conventional group. |
| 19 | Sauduran & Roulina (2021) | Attractive : Innovative Education Journal | The Quantum Learning Model increases a person's capacity to solve mathematical problems. As a result, because it can improve students' ability to solve mathematical problems during the learning process, the Quantum learning model is projected to be used as an alternative to traditional learning that stands alone. |
| 20 | Zaharah et al., (2021) | Journal of Scholar : Journal of Mathematics Education | Before and after utilizing multimedia mathematics learning based on Quantum learning, students' mathematical communication skills vary greatly. |
| 21 | Karlina et al., (2020) | JURING (Journal for Research in Mathematics Learning) | 1) Students who use the Quantum model are different from students who do not use the Quantum model in their mathematical communication skills.<br>2) There is no contact with students to improve learning without a learning paradigm. |

Mathematical Communication Capacity relates to a student's ability to articulate and explain mathematical proposals to others in a clear and orderly manner. Quantum learning is a method of learning where the interaction between teacher and student creates an exciting and successful learning place. Furthermore, self-efficacy refers to students' confidence in their ability to do something successfully. According to research, the quantum learning paradigm can help students with high self-efficacy improve their mathematical communication skills.

Among the factors that master self-efficacy, mathematical communication skills, and Quantum learning, there are several that stand out: 1) the learning environment, which makes the student more motivated to learn and more likely to actively participate in his studies. 2) The ability to manage emotions, significantly affects self-efficacy and interpersonal communication skills. When a person can overcome difficulties while communicating, he or she is more likely to accept themselves and communicate more effectively. 3) The sensitivity of the material, which may have an impact on the student's self-efficacy and mathematical communication skills. Material that is too easy or too difficult can be a source of low motivation in mathematical communication. 4) Learning style, as one factor, can improve self-efficacy, mathematical communication skills, and Quantum Learning. For example, students who enjoy visual learning will find it easier to understand the teacher's lesson plan and communicate with him. 5) Social networks, such as those provided by friends and family, can improve self-efficacy, mathematical communication skills, and quantum learning. Students who received help had higher self-efficacy and were more confident in speaking, whereas students who did not receive help had lower self-efficacy and were more afraid and anxious about speaking. Therefore, in Table 3 it is explained that students who have a high feeling of self-efficacy can fully utilize all mathematical communication markers. He can convey his mathematical reasoning in the form of mathematical communication to find the right answer to the problem, despite some mistakes. Students with high self-efficacy view challenging endeavors as challenges(Viki & Handayani (2020) This suggests that students with strong self-efficacy can effectively explain their ideas (Supriyati et al., 2021). This is also in accordance with the results of research from Masitoh & Fitriyani, (2018) where there was an increase of 85% of students, with cycle I reaching 97.368% and cycle II reaching 96.491% and at the end of the first semester, 60% of students passed the performance exam with an average score of 68.46. This score increased to 77.14% of students who passed the proficiency exam in Cycle II, with an average of 77.86. Finally, students' mathematical self-efficacy was maintained at an average of 89.77 after the period I. This finding was supported by conclusions in Cycle II, when students' mathematical self-efficacy was high (average 93.31). They seem eager to express their mathematical views. At the same time, students lacking self-efficacy struggled to explain their math concepts effectively. They remain difficult to solve difficulties and lack comprehensiveness. As a result, self-efficacy affects students' mathematical communication skills and Quantum learning paradigms. The higher one's self-efficacy, the greater one's mathematical communication skills.

Furthermore, the Quantum Learning Paradigm, as well as mathematical communication capabilities, are all connected. Student self-efficacy represents their belief in their capacity to complete a task or goal. Students with high self-efficacy tend to be more confident in expressing and explaining a learning topic, especially mathematics learning correctly and often, to others.

The capacity of students to communicate and explain mathematical topics to others clearly and regularly is called their mathematical communication skills. This ability is indispensable in the process of learning mathematics because it supports students in understanding ideas better and helps instructors in assessing students' knowledge. In addition

to these capabilities, the model used by instructors in learning is very significant. Quantum learning models were used in this study. Quantum Learning is a learning style that combines teachers and students interacting to create an engaging, peaceful, and productive learning environment. This learning paradigm uses interesting and entertaining strategies such as cooperative tactics, games, and visualization to assist students in increasing learning motivation and improving their mathematical communication skills. Therefore, according to Table 3, self-efficacy can affect mathematical communication and quantum learning models. This is supported by research findings that show differences in mathematical communication skills between students who use the Quantum Learning paradigm and those who do not (Karlina et al., 2020). In addition, several studies show differences in students' mathematical communication skills before and after using multimedia-based mathematics education based on Quantum Learning (Zaharah et al., 2021). This shows that self-efficacy can increase because it is influenced by mathematical communication skills and quantum learning models, meaning that the higher a person's level of self-efficacy, the more positive the person. A sense of positivity plays an important role in a person's self-efficacy. Someone who has a positive sense in him will also affect with positive communication skills as well. Conversely, a negative assessment of himself will make a person have low communication behavior As a result, it can be concluded that self-efficacy has a relationship with mathematical communication skills and Quantum Learning models.

## 4. CONCLUSION

The writing of this Literature Study is related to the improvement and relationship of mathematical communication skills through quantum learning based on self-efficacy published on Google Scholar. The first result revealed that related articles or journals presented from 2018 to 2023 show that an increase in communication skills can be done through quantum learning models and based on self-efficacy. The second result, there is a relationship between mathematical communication skills through quantum learning and self-efficacy. So it can be concluded that there is an improvement in mathematical communication skills through quantum learning models and self-efficacy and there is a relationship between mathematical communication skills, quantum learning models, and self-efficacy

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# *SYSTEMATIC LITERATURE REVIEW:* MATHEMATICAL CONNECTIONS THROUGH PROBLEM-BASED LEARNING IN TERMS OF ADVERSITY QUOTIENT

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**ABSTRACT**

Mathematical connection is a skill needed to understand mathematical concepts and relate them to formulas taught, once taught, applied in other subjects, and applied to the real world. Every student has differences in terms of mathematical connection ability. This is known as the Adversity Quotient (AQ). AQ is divided into three groups: Climbers, Campers, and Quitters. Apart from the AQ review, an appropriate learning model to improve students' mathematical connections is the Problem-Based Learning (PBL) model. PBL is a learning model related to everyday problems. This study aims to (1) determine the effect of AQ on mathematical connection skills in the PBL learning model and (2) determine the influence of AQ on mathematical connection skills. The discussion in this article uses the SLR (System Literature review) method searched from Google Scholar, Scimago Journal Rank, and Publish or Perish from 2013 to 2023. The results of this study get 22 relevant articles. Of the 24 articles studied, 14 concluded that mathematical connections are appropriate for PBL learning models, and eight concluded that AQ's effect on students' mathematical connections is proportional or directly proportional. Students with a good AQ will have good math connections.



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## 1. INTRODUCTION

In the preamble of the 1945 Constitution, one of the objectives of the Indonesian state was to educate the nation's life. According to Law No. 20 of 2013, the national education system is a planned effort to create a learning process for students to develop their potential and provide religious knowledge, personality, wisdom, noble morals, and also the skills needed for themselves, society, and the country. Mathematics is a science that can help in problem-solving. With mathematics, humans are accustomed to thinking systematically,

scientifically, logically, and critically.

Mathematical connections are a compulsory skill to build. With good mathematical connection skills, it can help students connect mathematics with everyday life, can feel the benefits of learning mathematics, and can also prolong the way students understand mathematics. According to Siagian (2016) in the mathematics curriculum in schools, mathematical connections are basic mathematical abilities that must be mastered by students at the secondary school level. The ability to make mathematical connections needs to be developed through learning models. The selection of learning models used must be of high quality(Syaiful et al., 2021). The learning model has a profound effect on the learning process and outcomes(Brinus et al., 2019; Cahyaningrum et al., 2019; Hanifah et al., 2019).

Problem based learning (PBL) is a problem-based learning method, encouraging students to learn to get a solution to a problem both individually and in groups, to think critically, and to be able to determine and use appropriate sources of subject matter. PBL is a learning model that can help students improve their skills(Hotimah, 2020).

In fact, many studies have found that students are still relatively weak in their math connection ability. One of them is research by Kenedi et al. (2019) Hanarafa (2021), Ningsih et al., (2020), and Hati et al., (2022) which indicates that students have a relatively low level of mathematical connection ability. In addition to the selection of learning models that must be appropriate, the ability to tolerate adversity is an important aspect of a person's quality of life known as the Adversity Quotient (AQ). According to Suryaningrum et al., (2020) showed that people with high AQ perform better than people with low AQ. AQ provides strong motivation for people to solve the problems they face so that AQ can support someone to succeed. Stoltz divided individuals into three groups of AQ: quitters, campers, and climbers. Quitter is a term for those who like to give up, Campers is a term for people satisfied with certain achievements, and Climbers is a term for people who continue to want to achieve success.

Based on the description above, it is hoped that this research can conclude that there is an appropriate learning model to be able to improve students' mathematical connection skills. Through the review of the Adversity Quotient, it is expected to be able to determine the effect of students' mathematical connection abilities based on their AQ level.

## 2. METHOD

This study used the Systematic Literature Review (SLR) method. According to Triandini et al., (2019) the SLR method is used to identify, evaluate, then interpret all research in a particular field with relevant research questions. According to Novitasari et al., (2019)the purpose of this Systematic Literature Review research is to help overcome the problems faced and identify different points of view on the problem being studied and show theories that are in accordance with the problems in the research.

In the initial data collection, many relevant articles were obtained from Google Scholar, Scimago Journal Rank, or Publish or Perish from 2013 to 2023. This search is done with with the keywords *koneksi matematika, model PBL, adversity quotient (AQ), koneksi matematika dan PBL, koneksi matematika dan AQ,* mathematical connections, problem-based learning, and adversity quotient (AQ), mathematical connections and PBL, mathematical connection and AQ. Further articles are selected based on the suitability of the content. After being reviewed based on the content, 22 articles relevant to the content were taken and used as literature in this SLR method. The articles used are then summarized and presented in the form of tables based on the name of the journal, author, and research results.

**Research questions:**

1. What learning model is appropriate to use to measure mathematical connections?
2. How does the mathematical connection affect AQ?

## 3. RESULTS AND DISCUSSION

### 3.1. Results

From several articles taken, the results of this study obtained 22 articles that are relevant to the research question. The 22 articles were detailed into 14 research articles on mathematical connections in PBL learning models and 8 research articles on mathematical communication in terms of adversity quotient.

1. **Research on mathematical connections in PBL learning models**
   The table below contains some research articles on mathematical connections that are suitable to be applied to PBL models

**Table 1**. List of articles regarding the connection of mathematics to PBL

| Journal | Written | Research Results |
|---|---|---|
| PRISMA Tahun 2022, Volume 5, Hal 612-618 | Nur et al., (2022) | PBL with a STEM approach is effective for students' mathematical connection skills. |
| *Jurnal Pembelajaran Matematika Inovatif* Vol. 1, No. 4, Juli 2018 | Rohmah & Mahardika (2018) | Students' mathematical connections can improve with the PBL approach. They are able to understand and relate concepts when solving problems in everyday life |
| AKSIOMA: *Jurnal Program Studi Pendidikan Matematika* Vol. 11, No. 2, 2022 | Aisyah et al., (2022) | The application of the PBL model has a good influence on the development of students' mathematical connections. |
| SIGMA: Jurnal Pendidikan Matematika Vol.13 Nomor 1, | Salim & Pitriani (2021) | There is a good influence between PBL and students' mathematical connection skills |
| JP3M *Jurnal Penelitian Pendidikan dan Pengajaran Matematika* vol. 3 no. 1, pp. 39–44, Maret 2017 | Herawati (2017) | Improving students' mathematical connections with geogebra app-assisted PBL is no better or the same as non-geogebra app-assisted ones. |
| Seminar Nasional Pendidikan Matematika (SENPIKA) | Trisnawati et al., (2019) | The student's mathematical connection with PBL is |

| | | |
|---|---|---|
| 4 Agustus 2018 | | classified as a high qualification. |
| *Jurnal Dedikasi Pendidikan*<br>Volume 6, No. 2, Juli 2022<br>: 503-514 | Muliana et al. (2022) | The mathematical connection of students with PBL models is superior to through a scientific approach to linear system material. |
| Indonesian Digital Journal of Mathematics and Education<br>Vol. 6 No. 2 2019 | Diana (2019) | A student's mathematical connection with PBL is better than with a hands-on learning model. |
| Jurnal Pendidikan Matematika<br>Vol. 3, No. 3, 2014 | Sugiarti & Basuki (2014) | Students' math connections with PBL are better than conventional learning |
| Jurnal Pena Ilmiah<br>Vol. 2, No. 1 2017 | Afifah & Irawati (2017) | PBL math learning can improve students' math connections |
| Formosa Journal of Sustainable Research<br>Vol.1, No.2, 2022 | Fefri Wahida & Andriyani (2022) | PBL models are effective for measuring students' mathematical connections to probability mathematics. |
| Seminar Nasional Matematika Dan Pendidikan Matematika (6thsenatik) 2021 | Anggraini (2021) | There is a good influence on students' mathematical connections to the PBL learning model. |
| Prosiding Seminar Nasional Matematika dan Pendidikan Matematika (Sesiomadika) 2018 | Nuraeni & Effendi (2019) | A student's mathematical connection with PBL is better than with regular learning. |
| Journal of Medives<br>Vol. 2, Nomor 1, 2018 | Atiningsih (2018) | Students' math responsibilities and connections can increase with PBL |

Based on Table 1 which contains a collection of articles from the last 10 years, it can be concluded that PBL is suitable for improving students' mathematical connections.

In the description of 14 articles taken from the last 10 years, 14 articles concluded that the PBL learning model is very appropriate to be used to measure mathematical connections. PBL is a learning model that is able to relate mathematical connections to everyday problems

**2. Research on mathematical connections reviewed from AQ**

The table below contains some research articles on mathematical connections in PBL learning models reviewed from AQ .

**Table 2**. List of articles regarding the connection of mathematics to AQ

| Journal | Written | Research Results |
|---|---|---|
| *Jurnal Pendidikan Indonesia.* Volume 1, Nomor 3, 2020 | Azizah (2022) | A student's mathematical connection ability can be affected from a student's AQ. |
| Mathedunesia Jurnal Ilmiah Pendidikan Matematika Vol. 9 No. 1 2020 | Mafulah & Amin (2020) | The math connection of students in the quitters group in solving math problems was lower than that of the campers and climbers group. |
| International Journal of Research in Education Vol. 2, No. 1, 2022 | Viyani et al. (2022) | Mathematic communication skills on the subject of AQ meet all indicators of mathematical communication skills is climbers |
| Unnes Journal of Mathematics Education Research 2022) 8-13 | Konita et al. (2020) | Evaluation of mathematical connection based on AQ shows that different AQ students will have different mathematical connection ability |
| ICE 2019, Purwokerto, Indonesia EAI DOI 10.4108/eai.28-9-2019.2291035 | Purwaningsih et al., (2020) | Mathematical Aspects of Communication Emerging from Students of Quitters in Solving a Problem of a System of Two-Variable Linear Equations |
| Juring (Journal for Research in Mathematics Learning) Volume 3, Nomor 2, 2020 | Dalti & Kurniati (2020) | The difference in mathematical connections in students who have high, medium and low fighting power is very noticeable. |

| | | |
|---|---|---|
| JP3<br>Vol. 17, Nomor 7, 2022 | Adiningsih et al. (2022) | The mathematical connection capability indicator on AQ Climbers is met so that it has good mathematical connection ability |
| Journal of Physics: Conference Series<br>IOP Publishing<br>ICCGANT 2020 | Yuniarti & Putra (2021) | Almost all the indicators of the quittes group can not be met, several indicators of the camper group can be achieved, and all the indicators of mathematics and communication of the climber group can be achieved. |

Based on Table 2, in the last 10 years, articles on the ability of mathematical connections reviewed through adversity quotient have been widely examined. The results of his research referring to the the reviewed articles showed such as Mafulah & Amin (2020), Konita et al. (2020), Adiningsih et al. (2022), and Yuniarti & Putra (2021) that AQ is directly proportional to the ability of students' mathematical connections. At the AQ level, it is divided into 3 parts, namely from the highest Climbers, Campers, and the lowest is Quitters and students who have the level of climber have high mathematical connections as well. Student climbers are able to connect, associate, and solve math problems.

## 4. CONCLUSION

Looking at the results and discussion, the conclusions of this study are: (1) The PBL learning model is appropriate to improve students' mathematical connections. (2) The effect of AQ on mathematical connection ability is proportional or directly proportional. The AQ level is divided into 3 sections, the highest is Climbers, then Campers, and the lowest is Quitters. Students with the AQ Climber level have higher mathematical connection skills compared to the other 2 levels. A good AQ in this case is the position of Climbers.

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# THE ROLE OF MOODLE IN EDUCATION: A BIBLIOMETRIC REVIEW

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**ABSTRACT**

Moodle is a trendy digital learning platform in education widely used to create online courses. Moodle's role in education is crucial because it provides many benefits, including facilitating distance learning, increasing student participation, increasing teaching efficiency, enabling easy assessment, enabling personalized teaching, and so on. There have been many studies on Moodle in the form of articles from year to year. Therefore, in this research, a bibliometric study will be carried out on the roles of Moodle in the world of education, mapping research results, looking at research trends, and looking for possible gaps that can still be studied more deeply. The method used in this research is a Systematic Literature Review using bibliometric analysis with the help of VoS Viewer. The study results show that Moodle is widely used to benefit learning in various fields, especially STEM. Moodle is generally used to digitize learning, including, in this case, the assessment and gamification process in learning.



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## 1. INTRODUCTION

In the world of education, moodle is used as an online learning platform. Moodle is a web-based Learning Management System (LMS) accessed using any device with an internet connection. Moodle has many features that make it suitable for educational institutions, significantly higher education. Universities in Indonesia have widely adopted this LMS. Some well-known universities in Indonesia, such as UGM (https://elok.ugm.ac.id/), UNESA (https://vinesa.unesa.ac.id/), University of Indonesia (https://emas.ui.ac.id/login/index.php), UNY (https://besmart.uny.ac.id/v2/) and many other

universities use Moodle as a University LMS. It is not surprising that this LMS is very popular LMS among academics both in Indonesia and around the world.

Some of Moodle's advantages include being an open-source, accessible platform. It can be customized according to the capabilities and wishes of the developer, available in the form of a mobile application, supports various languages and can be integrated with various CMS (Content Management Systems) or other learning applications (Kurniawati et al., 2020). A good LMS has at least five features: administrative features, teaching material features, testing features, assessment features, and integrated communication features (Retnoningsih, 2017). These features are already available in Moodle, so this LMS is reasonably complete.

Moodle has an assessment facility that can be used to test students' understanding of the material taught (Triyana et al., 2019). There are various forms of questions, such as multiple choice, true-false, matching, and even essay questions, that can be used as assessments (Chrisnawati et al., 2020). Another advantage is that the STACK plugin facility is available, which can be used for writing complete mathematics (Tomilenko & Lazareva, 2020). Complete math writing facilities are rarely found in quiz maker software or LMS.

Moodle is a platform that can be used as a blended learning medium. Blended learning combines face-to-face learning techniques in class and online learning (Gámiz Sánchez et al., 2014). Online learning itself can be done in two ways, namely synchronously or asynchronously. For asynchronous learning, you can use teaching materials in videos uploaded to the system (Edwards et al., 2019) or other products, such as electronic books in the form of EPUB (Prasetya et al., 2020). Whatever the form, teaching materials stored in the Moodle system can be accessed anywhere and anytime as long as they are connected to the internet.

Currently, LMS is widely used as an asynchronous learning media. Students busy with school activities and want additional lessons but need more time to participate in offline activities prefer online learning (Mursito, 2019). Likewise, students who do not have time to go to college because of certain obstacles can still get material according to what is presented in class.

Apart from functioning as a learning medium, Moodle can be used to measure one's learning independence. Through the activity log in Moodle, student learning activities can be monitored so that tutors/teachers can see how far students are trying to study independently (Pratiwi, 2022).

The literature review above shows that many researchers have discussed Moodle. The reviews vary from development, implementation, effectiveness, assessment, etc. Various research topics on Moodle have been discussed in many articles. As of February 5, 2023, around 1917 articles were recorded in the dimensions database in 2013-2022, specifically for the education sector.

Therefore, in this research, a bibliometric study will be carried out on the roles of Moodle in the world of education, mapping research results, looking at research trends and looking for possible gaps that can still be studied more deeply.

## 2. METHOD

The method used in this research is a Systematic Literature Review using bibliometric analysis with the help of VoS Viewer. The VoS Viewer software has five analysis types, each with its study unit. The five types of analysis are Co-Authotsip, Co-Occurrence, Citation, Bibliographic Coupling and Co-Citation. In this research, two types of analysis will be used, namely Co-Authorship and Co-Occurrence. The first type will be studied in a deductive way, namely through the author's partner in terms of the author's

country, organization, and between authors. Co-occurrence is a type of analysis that reviews the literature on the occurrence of keywords in articles.

There are many places to retrieve research article databases, including Google Scholar, Web of Science, Scopus, Dimensions, and PubMed. Software that can be used to search for article data without entering the indexer site can use Publish or Perish. However, in this study, the database used was the Dimensions database, whose articles were taken directly from the Dimensions website. There are several sampling considerations in database Dimensions. First, several bibliometric studies on Moodle use the Scopus database, so it is not good to use the same database. The complete metadata of all databases besides Scopus is metadata from web Dimensions. PoP software is not used because publication-type filtering facilities are not available.

The Dimensions database was used for 2013 – 2022, specifically for articles in the form of journals in the field of education that contain the keyword "Moodle". Article data is stored in RIS and CSV formats. Using the VOS Viewer, RIS files are used to analyze co-occurrence based on keywords, while CSV is used to analyze co-authorship in terms of country, organization, and author names.

## 3. RESULTS AND DISCUSSION

### 3.1. *Co-Authorship* Analysis (Country)

Articles as many as 1917 data were detected from 101 countries. The minimum number of co-authorships between countries is taken, namely 10, to get 25 countries that comply. These 25 countries are divided into 7 clusters and are marked with colored circles in Figure 1.

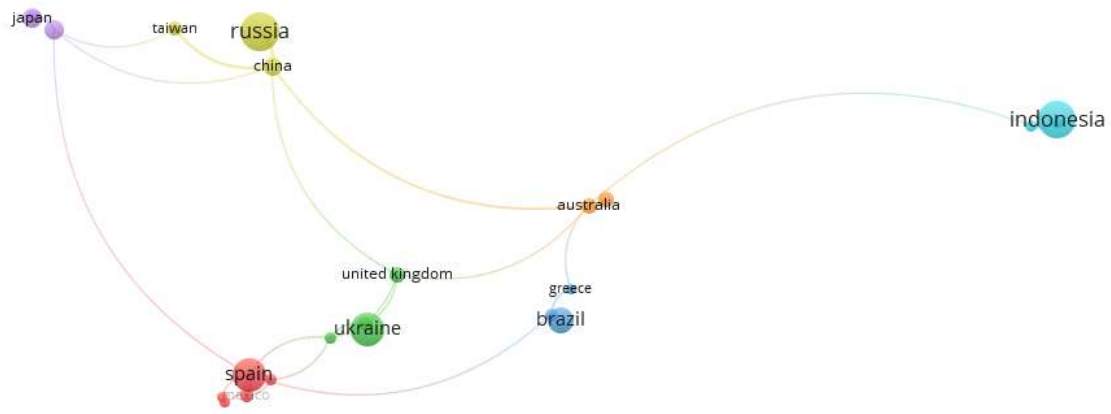


**Figure 1.** Network Visualization for Co-authors with country units

Each cluster consists of several countries. Cluster 1 Spain (93.1028), Mexico (15.55), Italy (12, 134), Colombia (11.16), Morocco (11.159). Cluster 2 Ukraine (93,230), United Kingdom (20,186), Turkey (18,175), Finland (12,185). Cluster 3 Brazil (56.95), Portugal (15.201), Greece (10.313). Cluster 4 Russia (126,492), China (29,553), and Taiwan (18; 463). Cluster 5 Japan (34; 93), United States (34; 418), Serbia (15; 226). Cluster 6 Indonesia (119; 146), Malaysia (12; 174), Oman (10;71). Cluster 7 Australia (22,325), South Africa (22; 358). The numbers in brackets are the number of documents and citations, respectively. The ten countries with the highest number of documents can be seen in Table 1.

**Table 1.** 10 Countries With The Most Documents

| No | Country | Documents | Citations |
|---|---|---|---|
| 1 | Russia | 126 | 492 |
| 2 | Indonesia | 119 | 146 |
| 3 | Spain | 93 | 1028 |
| 4 | Ukraine | 93 | 230 |
| 5 | Brazil | 56 | 95 |
| 6 | Japan | 34 | 93 |
| 7 | United States | 34 | 418 |
| 8 | China | 29 | 553 |
| 9 | Australia | 22 | 325 |
| 10 | South africa | 22 | 358 |

When viewed from the two countries with the most documents, several Russian researchers used Moodle to learn Russian as a foreign language (Samchik, 2021), especially during a pandemic (Berardi, 2021). Moodle is also a distance learning facility for foreigners who will study at universities (Lapuzina & Lisachuk, 2017). Apart from learning foreign languages, moodle is also widely used in learning mathematics (Kaidalova & Gumennikova, 2022) or learning other sciences (Drozdova, 2021).

Moodle is widely used in Indonesia as an LMS for universities or high schools. Various research topics on Moodle were studied. Several teachers and researchers use Moodle as a learning medium with a flipped classroom strategy (Ninda & Mawardi, 2022; Sari & Mawardi, 2022; Sitanggang et al., 2022) or blended learning (Handayani, 2022). Some want to implement Moodle in learning (Fayanto et al., 2019), and some measure student perceptions or attitudes of student acceptance of learning using Moodle (Pramita et al., 2021; Thamrin et al., 2019).

### 3.2. *Co-Authorship* Analysis (Organisation)

VoS Viewer found 836 organizations from the article database. A minimum of 5 documents and three citations were taken, and only 31 organizations complied. Of the 31 organizations, only three universities have the strongest total links: Financial University, Sechenov University and St Petersburg University.

However, suppose a pair of authors with at least 1 document and 1 citation is taken. In that case, there are 346 clusters, and one of the clusters containing universities in Indonesia can be seen in Figure 2.


**Figure 2**. Network Visualization for Co-authors with organizational units

Several universities in Indonesia are interconnected, and one is connected to a university in Malaysia. This is under the analysis between countries which place Indonesia and Malaysia in one cluster. The ten universities with the most documents and citations can be seen in Table 2. Two of them are from Indonesia.

**Table 2**. 10 Universities that Have the Most Documents and Citations

| No | Organization | Documents | Citations |
|---|---|---|---|
| 1 | University of córdoba | 13 | 76 |
| 2 | State university of Jakarta | 11 | 14 |
| 3 | University of kwazulu-natal | 10 | 270 |
| 4 | Tomsk polytechnic university | 9 | 86 |
| 5 | University of Belgrade | 9 | 157 |
| 6 | Borys grinchenko kyiv university | 8 | 18 |
| 7 | Sultan qaboos university | 8 | 30 |
| 8 | Financial university | 7 | 4 |
| 9 | Nizhny novgorod state pedagogical university | 7 | 27 |
| 10 | State university of padang | 7 | 15 |

### 3.3. *Co-Authorship* Analysis (Author)

Of the 4,852 authors found, authors with at least four documents and at least two citations were selected. Ten authors were obtained from the specified minimum requirements, which can be seen in the picture. The largest circle indicates the highest number of citations. In this case, the three authors with the most citations are Ahmed Al-Azawei, followed by Garcia then Strang Kenneth.


**Figure 3.** 10 Authors who Have at Least 4 Articles and at Least 2 Citations

Al-Azawei investigated the satisfaction and intention of students to continue using e-learning or not. The proposed TAM model identified key factors that could explain student satisfaction in mixed learning acceptance in the Middle East (Al-Azawei et al., 2017). He also discussed the correlation of learning styles with student achievement in the blended learning mode using Moodle and the ILS (Index of Learning Styles). No correlation was found between the two (Al-Azawei & Lundqvist, 2015). In addition, he also compared the existing assessments in the model with Virtual Reality (VR) assessments. In terms of student performance, the two methods are no different. However, on the other side, the VR assessment succeeded in increasing student involvement in the evaluation because they were happy with the VR evaluation (Al-Azawei et al., 2019).

Regarding the assessment problem, the second author uses Moodle in conducting peer assessments, and according to Strang, this is also very effective (David Strang, 2015). He also predicts student learning outcomes based on logs of online learning activities recorded in Moodle (Strang, 2017). In this study, learning activity logs cannot be used to predict student performance or learning outcomes.

### 3.4. *Co-Occurrences* Analysis

The RIS files obtained from 1917 articles were processed through the VoS Viewer. Shared events are reviewed based on the keywords the article uses. By limiting each keyword to occur at least five times, 24 keywords are obtained, which form 6 clusters. Cluster I includes*: assessment, blended learning, feedback, formative assessment, ICT, motivation,* and *student engagement*. Cluster II includes *E-Learning, education, gamification, learning, learning management Systems,* and *satisfaction*. Cluster III includes *covid 19, educational technology, medical education, and online learning*. Cluster IV includes *digital technologies, distance learning, LMS Moodle,* and *mathematics*. Cluster V just only one is *collaborative learning, and the last cluster VI namely machine learning*. The following figure shows the density visualization.

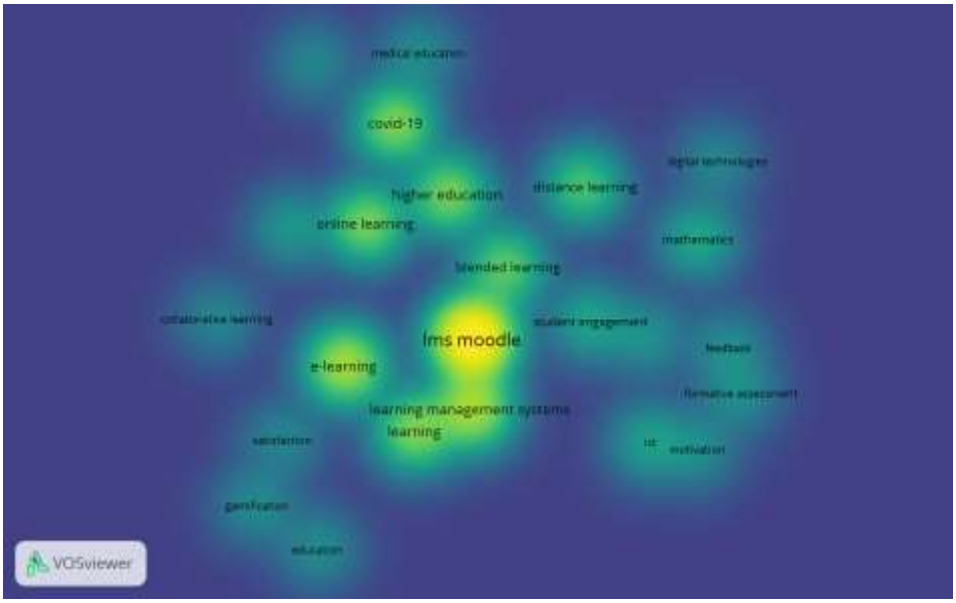


**Figure 4**. Density Visualization

Of the several clusters, several keywords clearly show that these keywords are the most frequently discussed of all the articles compiled. The brightest buzzword is "LMS Moodle." This is the main topic discussed in each piece. Then followed by special keywords "Learning Management System." Moodle is an LMS, but the LMS mentioned in the article is not necessarily Moodle. It could be Schoology, Chamilo, Microsoft Teams, Edmodo, and others.

The third position that is quite bright is "e-learning." All articles that discuss electronic learning can use these keywords, such as mobile learning, web-based learning, and all forms of knowledge that use electronic aids, including the LMS itself. In fourth place are "Covid-19" and "learning," which are just as clear. The fifth position is "higher education" and "online learning." Then there are "blended learning" and "distance learning," which are starting to fade. All keywords that are dim have the potential to be studied more deeply, but it is necessary to pay attention to the latest items so that research studies always have a new side. Therefore, it requires an overlay visualization display.

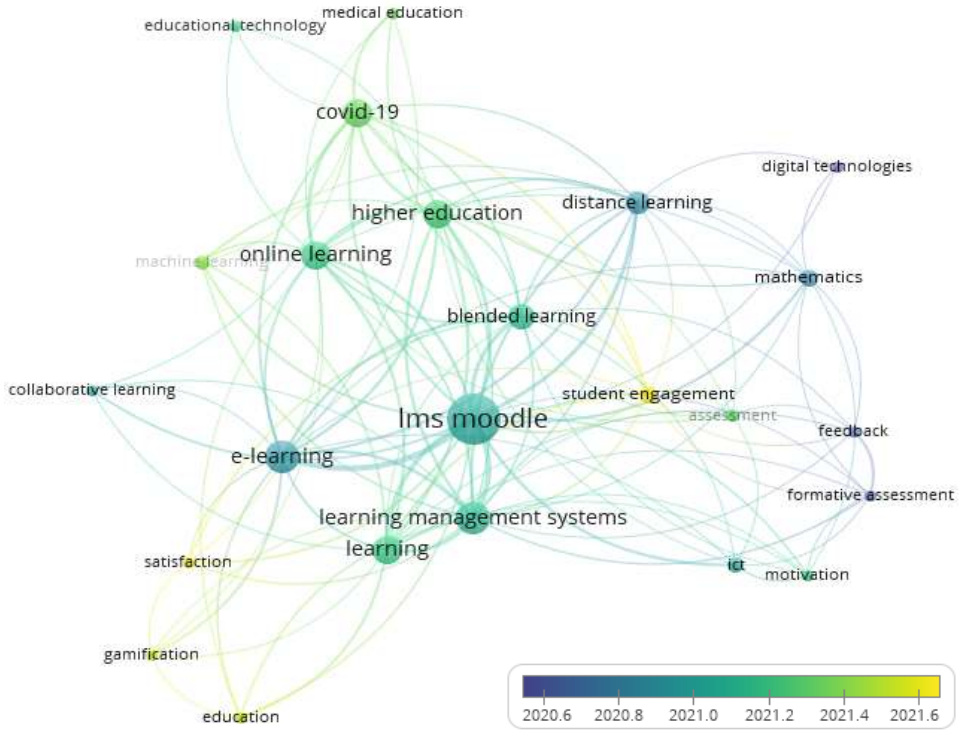


**Figure 5.** Overlay Visualization

From this visualization, keywords such as education, gamification, satisfaction and student engagement are the most recent keywords among all existing keywords. Included in this is the keyword assessment. All of these new keywords still have the potential to be studied further because the Density visualization section is rarely discussed.

The authors of the articles obtained from the dimension database came from 101 countries. This proves Moodle's use in education is prevalent in various countries. There have also been many collaborations between authors. The research found that Russians, followed by Indonesians, wrote most documents. However, the most cited articles were articles from Spain. There has been no co-authorship between these three countries.

The University of Córdoba from Spain is in the first place which has the most articles. The second place is occupied by the State University of Jakarta from Indonesia. Meanwhile, Padang State University is another university from Indonesia that is included in the category

of 10 universities with the most articles. From this visualization, it can be seen that collaboration between universities is still rare. Most of the authors' affiliations only occur within their respective organizations.

In Indonesia, Moodle is widely used as a university LMS. This platform can generally be used for any learning but mostly focuses on learning science, technology, engineering, and mathematics. This is to the results of research (Gamage et al., 2022), which states that learning using Moodle greatly focuses on the STEM field (Science, Technology, Engineering, and Mathematics).

Based on overlay visualization and density visualization, one of the keywords rarely studied, and relatively new is assessment. Moodle assessment can be developed by collaborating with several devices, for example, Ispring. Ispring is a fairly comprehensive quiz creation tool that can generate importable quizzes for some specialized LMSs such as Moodle. This issue is currently under study.

## 4. CONCLUSION

The results and discussion show that Moodle is widely used to benefit learning in various fields, especially STEM. Moodle is generally used for digitizing learning, including, in this case, the assessment and gamification process in learning. To get exact keywords, the keywords for each article need to be rechecked. The tool that can be used is Mendeley. However, because too many articles were reviewed, the keywords taken were output directly from the VoS Viewer without further examination. To produce accurate keywords, use a filtering method such as PRISMA to make the examined articles manageable.

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# RELATIONSHIP BETWEEN STUDENT DIFFERENTIAL AND INTEGRAL CALCULUS LEARNING OUTCOMES TO STUDENT DIFFERENTIAL EQUATIONS LEARNING OUTCOMES

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**ABSTRACT**

Differential and integral calculus courses are the foundations of mathematics that are important in understanding and applying differential equations. Students can take the Differential Equation course after graduating from the Differential Calculus and Integral Calculus courses. This study aims to determine the relationship between understanding differential and integral calculus and students' learning outcomes of differential equations. The population in this study were all 2020 Pattimura University Teaching and Teacher Training Faculty Mathematics Education students who had taken differential calculus, integral calculus, and differential equations courses, with a total sample of 33 people. The research method used is quantitative research with correlational methods. This study uses multiple regression analysis to find the form and influence between the independent and dependent variables. Based on the results of the data analysis, it was concluded that there was a significant contribution between learning outcomes of differential calculus on learning outcomes of differential equations seen in the relative contribution of learning outcomes of differential calculus on learning outcomes of differential equations based on the calculation results obtained 56.45% while the relative contribution of learning outcomes of integral calculus 43 .54% of the learning outcomes of differential equations. So it shows a significant influence between learning outcomes of differential and integral calculus on learning outcomes of differential equations.



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## 1. INTRODUCTION

The Differential Equation course is a compulsory subject for students of the Mathematics Education study program at Pattimura University. This course is offered in semester four (IV). The Differential Equation course has a sizeable study weight of three Semester Credit Units (SKS) and is a compulsory subject, meaning that all students are required to take the Differential Equation course. The material discussed is divided into six chapters namely, 1) basic concepts of differential and integral, 2) first-order ordinary differential equations, 3) second-order ordinary differential equations, 4) partial differential equations, 5) vector analysis, and 6) special functions. In chapter one, it discusses differentials starting from terms, basic examples, formulas, equations, rules and practice questions and then continues with integrals, namely the first basic theorem, second basic theorem, types, indefinite integrals, definite integrals, properties, formulas. , methods for finding integrals, applications and practice questions. Chapter two discusses direct integrals, variable separation, exact differentials, integral factor methods, linear differential equations, homogeneous and non-homogeneous differential equations, and Bernoulli's differential equations (Misbah et al., 2020).

Differential Equation is a very important subject not only in the field of mathematics but even for other fields of science because most other fields of science require the application of Differential Equation material. The importance of Differential Equations can be seen from Differential Equations as a prerequisite course for other courses such as Numerical Methods. Furthermore, Differential Equations are used in the fields of economics, physics, biology, civil engineering and various other fields related to the application of various events with the concept of a differential equation. In the economic field, the concept of the Differential Equation is applied to solve the problem of elasticity of demand, marginal, maximum profit, average control model and its relationship to marginal cost (Kustiawati et al., 2022). Even though Differential Equation is a very important subject that must be mastered by students, the facts on the ground show that many students do not complete the Differential Equation course. Research data from Paris & Assidiqi (2014) noted that the average student did not complete at 36.12%, and there were even classes where the percentage of students who failed the Differential Equation course was 50%. The research data was taken for 4 consecutive years.

The Differential Equation course is a conditional course, students are required to have taken the Differential Calculus course offered in the second semester and Integral Calculus offered in the third semester. Differential calculus and integral calculus are the foundations of mathematics that are important in understanding and applying differential equations. Therefore, learning outcomes of differential calculus and integral calculus can affect learning outcomes of differential equations. Differential Calculus and Integral Calculus have the same study load as Differential Equations, namely three (3) Semester Credit Units (SKS). The Differential Calculus course consists of six chapters, namely the real number system; function; limit and continuity; infinity limit; function derivative; use of derivatives (Azizah & Ariyanti, 2018). Differential Calculus is a prerequisite course for several courses other than Differential Equations, namely Integral Calculus and Advanced Calculus (Sumargiyani & Nafi, 2020). The materials discussed in Integral Calculus are indefinite integrals, definite integrals, transcendent functions, integration techniques, and integral applications (Siahaan, 2021). Integral Calculus is very important for students to master because it is a prerequisite course for several courses in the following semester besides the Differential Equations already mentioned. The courses are Advanced Calculus, Mathematical Statistics and Real Analysis (Muhassanah & Lukman, 2021). According to some research results, students' abilities in prerequisite courses, namely Differential

Calculus and Integral Calculus, will affect students' abilities in the Differential Equations course because the material studied in these courses is interrelated and continuous. Students need to understand Integral Calculus material. Students' understanding of Differential Calculus and Integral Calculus material is a reference in mastering Differential Equations material.

Research conducted by Nurlaili & Rifanti (2020) explained that the mistakes that students often make when working on Differential Equations are wrong in determining the integral factor in the initial step so that in the next step it becomes wrong resulting in the final result being inaccurate. The reason students make many mistakes when solving derivative and integral problems is because students do not have an understanding of the concept of integral and derivative material. Sulistyorini, (2017) revealed the results of research conducted on students of the Mathematics Education Study Program at the Budi Utomo Malang Teacher Training and Education Institute, namely that conceptual errors occur when students misunderstand. Students are not able to understand the concepts seen in the problems given, are not in accordance with procedures, and the application is not correct or cannot determine what relationships are in the problem. There are still many students who make mistakes when solving trigonometry derivatives, natural logarithms and exponentials. The results of this study also reveal that students often have difficulty determining solutions to problems related to natural logarithmic integrals, exponential integrals and integral trigonometric functions. The results of the research conducted by Sumargiyani & Nafi (2020) are in line with Nurlaili & Rifanti (2020) and Sulistyorini (2017). The research was conducted on students of the Mathematics Education Study Program, Ahmad Dahlan University, with the aim of analyzing the difficulties encountered when working on material problems of nth-order linear differential equations. The conclusion of the research results is that students are weak in solving problems related to integrals, and derivatives means that students have difficulty in the prerequisite material from the Differential Equation course.

Many studies have been conducted to explore the relationship between the understanding of differential and integral calculus and the results of students learning differential equations. Several studies have shown that students who have a better understanding of differential and integral calculus tend to be more successful in learning differential equations. For example, research conducted by Sari (2022) shows that understanding differential and integral calculus has a significant effect on student learning outcomes of differential equations. This research shows that students who have a better understanding of differential and integral calculus tend to have better learning outcomes in differential equations. Another study conducted by Wahyudi (2018) also showed similar results. This research shows that the understanding of differential and integral calculus has a significant effect on the results of students learning differential equations in a university. Based on the description that has been presented, this study focuses on "The Relationship between Differential Calculus and Integral Calculus Learning Outcomes to Student Differential Equation Learning Outcomes".

## 2. METHOD

The type of this research is a quantitative research with a correlational method. Quantitative research has data in the form of numbers that can be measured to get a conclusion. Quantitative data is based on concrete data using statistics for calculation test tools (Sugiyono, 2018). ). According to Creswell (2014) ) correlational research is research using statistical methods to see the relationship between variables in the study. This study uses multiple regression analysis which has the aim of finding the form and influence

between the independent variables and the dependent variable. The independent variable is the result of learning differential calculus (X1) and integral calculus learning outcomes (X2). The dependent variable is the result of learning differential equations. The population in this study were all 2020 Pattimura University Teaching and Teacher Training Faculty Mathematics Education students who had taken differential calculus, integral calculus, and differential equations courses with a total sample of 33 people. The data collection technique uses a documentation study, namely data taken from student siakad data including final grades in differential calculus, integral calculus, and differential equations courses.

Data analysis technique using multiple regression test. Sudarmanto (2005) revealed that a multiple linear regression model can be called a good model that has accuracy in estimation, is not biased and is consistent if it fulfills the assumption of normality and is free from classical assumptions. Ghozali (2009) further states that the multiple regression test requires prerequisite tests first, namely the normality test, linearity test, multicollinearity test, autocorrelation test, and heteroscedasticity test. All statistical analyzes used the SPSS 24 application. In this study, calculations were made of the effective contribution and the relative contribution of each independent variable.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

Data on learning outcomes of differential calculus, integral calculus and differential equations are presented in Table 1 below.

**Table 1.** Learning Outcomes of Differential Equations, Differential and Integral Calculus

| | **Learning outcomes** | | |
|---|---|---|---|
| | **Differential Calculus** | **Integral Calculus** | **Equations Differential** |
| The highest score | 93.34 | 92.50 | 80.00 |
| The lowest score | 41.35 | 36.03 | 21.00 |
| Mean | 66.1555 | 65.0865 | 53.3161 |
| Median | 65.60 | 64.12 | 50.05 |
| Standard Deviation | 13.32214 | 15.88567 | 15.37309 |

Based on Table 1, it is known that the highest learning outcomes are successively for the three subjects, namely differential calculus which is the highest compared to the highest learning outcomes in integral calculus and finally the learning outcomes of differential equations. The lowest score for the lowest learning outcomes is in the differential equations course compared to integral calculus and differential calculus. The same thing also happens to the mean and median, the mean and median values of the differential equation are lower in comparison two other courses respectively namely integral calculus and differential calculus. But for the standard deviation, the highest is the standard deviation of the integral calculus then the differential equation and the lowest is the standard deviation of the differential calculus. Before carrying out data analysis using multiple linear regression tests, a prerequisite test of multiple linear analysis was carried out first. The first test to be carried out is the normality test, namely the Liliefors test which is presented in Table 2.

Based on Table 2, it is obtained that the significance values of Asymp Sig (2-tailed) for differential calculus, integral calculus, and differential equations are 0.806, 0.364, and 0.438 respectively, which are greater than the value of $\alpha$ = 0,05 so that it can be concluded that the data on the learning outcomes of the three courses are normally distributed.

**Table 2.** Liliefors Test

| | Shapiro Wilk | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Differential Calculus | .980 | 31 | .806 |
| integral calculus | .964 | 31 | .364 |
| Differential Equation | .967 | 31 | .438 |

a. Lilliefors Significance Correction

The results of the multicollinearity test are shown in Table 3. Basis for decision making for tolerance multicollinearity tests and VIF according to Imam (2011) there are no symptoms of multicollinearity if the tolerance value is more than 0.1 and the VIF value is less than 10.00.

**Table 3.** Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. | Tolerance | VIF |
| 1 | (Constant) | -5.905 | 8.689 | | -.680 | .502 | | |
| | KALDIF | .542 | .238 | .470 | 2.277 | .031 | .293 | 3.414 |
| | KALINT | .359 | .200 | .371 | 1.800 | .083 | .293 | 3.414 |

Based on Table 3, the tolerance value of differential calculus and integral calculus is 0.293 more than 0.05 and the VIF value is 3.414 less than 10.00 so that the conclusion is that there are no symptoms of multicollinearity or there is no strong relationship (correlation) between the independent variables, namely the results of learning calculus differential and integral calculus. The heteroscedasticity test using the Glejser test is shown in Table 4.

**Table 4.** Glejser Test

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 14.274 | 5.352 | | 2.667 | .013 |
| | KALDIF | -.229 | .147 | -.519 | -1.559 | .130 |
| | KALINT | .118 | .123 | .318 | .957 | .347 |

a. Dependent Variable: Abs_Res

Table 4 shows that the value of sig. differential calculus is 0.130 more than 0.05 and the integral calculus sig value is 0.347 more than 0.05, there is no heteroscedasticity problem. Furthermore, the Durbin Watson autocorrelation Stest was carried out. Imam (2011) has no symptoms of autocorrelation if the Durbin Watson value lies between the values du to (4-du). The du value is obtained from the distribution of values in the Durbin Watson table based on k = 2 (number of independent variables) and n = 31 (number of samples) with a significance of 5%. From the table obtained du = 1.570 and 4-du = 2.43.

**Table 5.** Durbin Watson Test

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .807[a] | .651 | .626 | 9.39676 | 1.653 |

a. Predictors: (Constant), KALINT, KALDIF

b. Dependent Variable: PD

Table 5 shows the Durbin Watson value is 1.653 so that du (1.570) < 1.653 < 4-du (2.43) means that there are no symptoms of autocorrelation. Furthermore, an analysis was carried out with the F test and T test to determine the contribution of learning outcomes of differential calculus and integral calculus to learning outcomes of differential equations, the contribution of learning outcomes of differential calculus to learning outcomes of differential equations, and the contribution of learning outcomes of integral calculus to learning outcomes of differential equations. The F test was conducted to see the contribution of learning outcomes of differential calculus and integral calculus to learning outcomes of differential equations simultaneously.

**Table 6.** F Test

| **Model** | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|---|
| 1 | Regression | 4617.582 | 2 | 2308.791 | 26.147 | .000[b] |
| | Residual | 2472.375 | 28 | 88.299 | | |
| | Total | 7089.957 | 30 | | | |

a. Dependent Variable: PD

b. Predictors: (Constant), KALINT, KALDIF

The results from table 6 can be concluded that:

**Contribution of Differential Calculus and Integral Calculus Learning Outcomes to Differential Equation Learning Outcomes**

The significance value (Sig) of learning outcomes of differential calculus and integral calculus is 0.00 less than 0.05 so that the conclusion obtained is that there is a significant effect between learning outcomes of differential calculus and integral calculus on learning outcomes of differential equations.

The results of the linearity test obtained that there was a significant linear relationship between the independent variables namely learning outcomes of differential calculus and integral calculus with the dependent variable, namely learning outcomes of differential equations. Based on the results of the prerequisite test for multiple linear regression analysis, namely the normality test, linearity test, multicollinearity test, autocorrelation test, and heteroscedasticity test, it can be concluded that the multiple linear regression test is good to do.

**Table 7.** Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. | Tolerance | VIF |
| 1 | (Constan) | -5.905 | 8.689 | | -.680 | .502 | | |
| | KALDIF | .542 | .238 | .470 | 2.277 | .031 | .293 | 3.414 |
| | KALINT | .359 | .200 | .371 | 1.800 | .083 | .293 | 3.414 |

Based on the results from SPSS according to Table 7 the regression model can be

written as follows:

$$Y = -5{,}905 + 0{,}542X_1 + 0{,}359X_2$$

Information:
Y = learning outcomes of differential equations
$X_1$ = learning result of differential calculus
$X_2$ = integral calculus learning outcomes

**Table 8.** Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .807[a] | .651 | .626 | 9.39676 |

a. Predictors: (Constant), KALINT, KALDIF

b. Dependent Variable: PD

Table 8 shows the value of the coefficient of determination ($R^2$) reached 0.651 which can be interpreted that the contribution of the influence of differential calculus and integral calculus learning outcomes simultaneously (simultaneously) on the learning outcomes of differential equations that is equal to 65.1%, while the remaining 34.9% is influenced by other variables besides learning outcomes of differential calculus and learning outcomes of integral calculus. The sum of the values of the coefficient of determination ($R^2$) is equal to the sum of the effective contributions of the differential calculus and the effective contributions of the integral calculus. Effective contribution (SE) is a measure used to determine the amount or magnitude of the contribution of an independent variable to the dependent variable in the regression analysis. The relative contribution (SR) is a measure used to determine the amount or magnitude of the contribution of an independent variable to the determination ($R^2$). The sum of all the relative contributions of all independent variables is 100% or 1.00.

**Table 9.** Correlation and Regression Analysis Results

| Variabel | Koefisien Regresi Beta | Koefisien Korelasi (r) | $R^2$ |
|---|---|---|---|
| $X_1$ | 0,470 | 0,782 | 0,651 |
| $X_2$ | 0,371 | 0,766 | |

Based on Table 9, it is obtained that the effective contribution of differential calculus learning outcomes to differential equation learning outcomes reaches 36.75% while the effective contribution of integral calculus learning outcomes is only 28.35% to differential equation learning outcomes. This shows that learning outcomes of differential calculus have sa greater influence on learning outcomes of differential equations. Furthermore, the relative contribution of learning outcomes of differential calculus to learning outcomes of differential equations based on the calculation results obtained 56.45%, while the relative contribution of learning outcomes of integral calculus is smaller, only 43.54% of learning outcomes of differential equations. Furthermore, an analysis was carried out with the T test to determine the contribution of learning outcomes of differential calculus to learning outcomes of differential equations, the contribution of learning outcomes of integral calculus to learning outcomes of differential equations. The results of the partial t test can be seen in table 10.

**Table 10.** Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. | Tolerance | VIF |
| 1 | (Constan) | -5.905 | 8.689 | | -.680 | .502 | | |
| | KALDIF | .542 | .238 | .470 | 2.277 | .031 | .293 | 3.414 |
| | KALINT | .359 | .200 | .371 | 1.800 | .083 | .293 | 3.414 |

Based on table 10, several conclusions are obtained, namely:

**1. Contribution of Differential Calculus Learning Outcomes to Differential Equation Learning Outcomes**

The significance value (Sig) of differential calculus learning outcomes is 0.031 less than 0.05 so that the conclusion obtained is that there is a significant effect between differential calculus learning outcomes on differential equation learning outcomes if the integral calculus learning outcomes variable is included in the model

**2. Contribution of Integral Calculus Learning Outcomes to Differential Equation Learning Outcomes**

The significance value (Sig) of learning outcomes of integral calculus is 0.083 more than 0.05 so that the conclusion obtained is that there is no significant effect between learning outcomes of integral calculus on learning outcomes of differential equations if the variables of learning outcomes of differential calculus are included in the model.

### 3.2. Discussion

Differential Equations are one of the most important topics in mathematics and also in other fields because they are widely used in physics, engineering, and computer science. Students need to understand Differential Equation material in order to be successful in other courses that have Differential Equation as a prerequisite course. But the majority of students have difficulty learning differential equations. Student scores in the Mathematics Education Study Program FKIP UNPATTI who contracted the Differential Equation course in 2019 are still very low, far from satisfactory. Of the 35 students who attended the lecture, 24 of them were only able to get a D and one person even got an E. This means that more than half of the students do not understand Differential Equations. This is in accordance with research conducted by Khasanah (2018) that the ability of Mathematics Education students at UIN Raden Intan Lampung in the Differential Equation course is still low. Some research results reveal that students make many mistakes when solving Differential Equation problems because students do not understand concepts, principles, or operations related to integration or differential (Fauziah, 2019), (Sulistyorini, 2017), (Rejeki & Setyaningsih, 2016), (Saparwadi, 2018).

Students' abilities in the Differential Equation prerequisite courses, namely Differential Calculus and Integral Calculus have a significant contribution to the results learn Differential Equations.Yanti (2017) stated that the final score of Differential Calculus or Calculus 1 and the final score of Integral Calculus or Calculus 2 simultaneously contributed to the final Differential Equation score of 34.70 percent. Therefore, a good understanding of differential and integral calculus is needed by students in learning differential equations. In the opinion of Nursalam et al., (2014) there is an effect of mastery of prerequisite material on learning outcomes. This research was conducted on students who contracted the Differential Equation course in the even semester of the 2021/2022 academic year. The result

of the research is that there is a significant influence between learning outcomes of differential calculus on learning outcomes of differential equations. This result is different from the results of learning Integral calculus on learning outcomes of differential equations, namely there is no significant effect. However, for the effect of the prerequisite material simultaneously or together, it was found that there was a significant effect between learning outcomes of differential calculus and integral calculus on learning outcomes of differential equations. The results of this study are supported by previous research conducted by Rejeki & Setyaningsih (2016) namely the partial contribution of Differential Calculus, Integral Calculus to Differential Equations respectively 62% and 38%. For the simultaneous contribution of the two prerequisite courses it reached 63%.

## 4. CONCLUSION

Based on the results and discussion, there are several conclusions that can be drawn in this study, namely: (1) there is a significant contribution between learning outcomes of differential calculus on learning outcomes of differential equations, (2) there is no significant contribution between learning outcomes of integral calculus towards learning outcomes of equations differential, (3) there is a significant contribution between learning outcomes of differential calculus and integral calculus towards learning outcomes of differential equations. Some suggestions based on the results of this study are (1) students must have good skills in differential calculus and integral calculus courses because they have a very strong influence on differential equation learning outcomes, (2) lecturers must choose a learning model that can improve learning outcomes in differential equations course.

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# BASIC ALGEBRA ABILITY ANALYSIS OF JUNIOR HIGH SCHOOL STUDENTS WITH THE RASCH MODEL APPROACH

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**ABSTRACT**

The purpose of this study was to determine students' basic algebraic abilities based on the analysis of the items (items) and the analysis of students' abilities (person) using the Rasch modeling. The instrument used was a test instrument in the form of multiple choices about algebraic material. This test was given to 662 students of class VIII and IX at SMP Negeri 5 Kendari. Data analysis was performed by RASCH modeling using the Winstep application.The results of the person analysis stated that the overall ability of the students was greater than the difficulty level of the questions. The basic Algebra ability possessed by all students are higher than the difficulty level of all the algebra questions tested. This shows that the consistency of students' answers in solving multiple choice questions on algebraic material according to the level of difficulty is strong or good, but the quality of the items used in collecting data on students' algebraic abilities is of moderate quality.



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## 1. INTRODUCTION

Technological developments become a reference for change and education reform to continuously adjust and improve the curriculum in responding to future challenges. With the emergence of the Independent Campus Learning Center (MBKM), it requires elements of education to carry out and respond to increasingly stringent challenges in the future. The

quality of education is of course the main goal of education in Indonesia, so as to achieve this. It is necessary to analyze student learning outcomes using standardized tests. This is due to the fact that there are still many teachers who use questions from textbooks that are already available for which the quality and reliability of the test questions are not known (Rustam & Kasmawati, 2021).

The quality of education cannot be separated from the learning process in the classroom and a good evaluation process. To form students' critical thinking skills requires great effort for educators. The ability to think critically one of the most relevant subjects is mathematics. Mathematics lessons are still very much a hot topic of conversation in the classroom. Various challenges arise both from students, teachers, that the available means. Mathematics is an abstract science and not everyone likes it. This is shown from the results of Chotimah's research, it was found that junior high school students' mathematical understanding was still low (Chotimah, 2014).

Learning mathematics, especially certain materials, requires serious understanding in understanding the concept. Mathematics teaches something abstract, especially in algebra material. Algebraic material contains abstract symbols and requires a sufficient understanding of ability to learn it. The results of Male's research, in students at one of the junior high schools found that in one class consisting of 35 students, only 5 students were already at the formal (abstract) thinking stage, while 30 students were at the concrete operational thinking stage, so they had difficulty understand mathematical concepts that are still abstract to them (Putra, 2014).

Algebra material in mathematics lessons offers a variety of abstract concepts. One that is sometimes difficult for students to understand is the laws of algebra, so that in algebraic operations students often make mistakes in solving a problem.

Of course, as a teacher, you must be able to identify student weaknesses in solving a problem in teaching material, especially those related to the basic concepts of algebra, namely algebraic laws. Understanding the laws that apply to algebraic operations will make it easier for students to solve problems with various forms of problems. Symbols have different interpretations so students have the opportunity to experience misconceptions (Afriansyah, 2016; Nurmawanti & Sulandra, 2020). Utami (2017) explained, that students experience misconceptions in adding and subtracting coefficients with constants. In addition to that algebraic concepts are closely related to problems in everyday life that are encountered by students, the inculcation of the initial concept for material in algebraic forms in junior high school students is very important because it is still fundamental (Utami, 2017).

Early detection of students' abilities and understanding of basic algebraic concepts is the best alternative so that students have no difficulty learning further material, especially those related to algebraic operations that use abstract symbols. It is necessary to analyze students' abilities, to what extent they understand the basic algebraic concepts. To measure basic algebra ability students must use test instruments that can provide accurate information according to the actual conditions of students. In order to be able to help students appropriately, it is necessary to know in advance whether the difficulties or problems faced by these students are then analyzed and formulated solutions (Iriyadi et al., 2022).

This research will analyze students' basic algebraic abilities based on the analysis of items (items) and analysis of students' abilities (person). Item analysis explains the contribution of the test instrument in explaining students' algebraic abilities in solving basic algebraic concepts. Analysis of students' abilities shows students' algebraic abilities in solving algebraic concepts, especially those related to algebraic laws. Item analysis and student ability analysis were simultaneously carried out using the RASCH model.

Rasch modeling will provide valid information in demonstrating students' basic algebraic abilities. Rasch modeling will create a hierarchical relationship between the examinee (person) and the items used. Because it produces the same interval scale with the same logit units for the person and the items (Kurniawan & Andriyani, 2018). In addition, the Rasch Model approach is due to: (1) being able to predict missing data scores based on systematic response patterns, (2) being able to identify person capabilities through identification of error responses, (3) being able to identify guesses, (4) being able to analyze person abilities which does not depend on the number of correct answers, and (5) is able to make a measurement scale with the same interval (Sumintono & Widhiarso, 2015). The purpose of this study was to determine students' basic algebraic abilities based on the analysis of the items (items) and the analysis of students' abilities (person) using the Rasch modeling. The purpose of this study was to analyze the basic algebra ability of junior high school students using the Rasch Model approach.

## 2. METHOD

This research was conducted at SMP Negeri 5 Kendari. Algebra material has been taught in schools since class VII, so the class that is used as a respondent is students in class VIII and IX with the assumption that students have studied algebra material. Therefore, the research respondents in the study were 662 students.

The research instrument used is a test instrument in the form of multiple choices about the basic concepts of Algebra. The test items consist of fifteen numbers that measure students' basic algebraic abilities and their understanding of algebraic laws. Data is taken based on the scores obtained by students from the results of examining their answer sheets.

Giving scores on student answer sheets based on the multiple-choice assessment rubric is true or false according to the answer key. Mok and Wright explained that the concept of objective measurement in educational assessment must have five criteria, namely "(1) Provide a linear measure with the same intervals, (2) Carry out an appropriate estimation process, (3)

Find items that are incorrect (misfits) or unusual (outliers), (4) Overcome missing data, (5) Produce replicable measurements (independent of the parameters studied). Based on these five conditions, so far only the RASCH model can meet these five conditions." (Sumintono, 2021).

Objective measurement, as well as application of the Rasch Model in educational assessment with the use of software or applications designed for Rasch modeling (Bond & Fox, 2007). The data obtained were analyzed using RASCH modeling with the help of WINSTEPS software. Data on students' basic Algebra ability test scores in Microsoft Excel format were prepared and after that the data type was adjusted to the WInsteps program, namely using the file type "*.prn" which can be read through the notepad program. The data analysis process then prepares the data format in the Ministep program for modeling

RASCH. The results of research data analysis using RASCH modeling are carried out as follows:

a. Analysis of the WRIGHT Map (person-item map), which is a map that describes the distribution of students' abilities and the level of difficulty of the questions on the same scale.
b. The analysis of the items includes the level of difficulty of the items (item measure), the level of suitability of the items (item fit) and the detection of biased items.
c. Analysis of student capabilities includes the level of individual ability ( pearson measure), the level of individual suitability (person fit)

d. Instrumental analysis is a comprehensive analysis with RACH modeling as a whole with more detail in the form of statistical summaries and test information functions that will guide researchers in making appropriate, logical and scientific decisions.

## 3. RESULTS AND DISCUSSION

### 3.1. Wright Map Analysis (Person – Item Map)

Analysis of the ability of Algebraic concepts possessed by 662 students in grades VIII and IX of junior high school. The understanding of algebraic laws is described comprehensively in the RASCH model through Wintesp's output, namely the Wright map as shown in Figure 1.

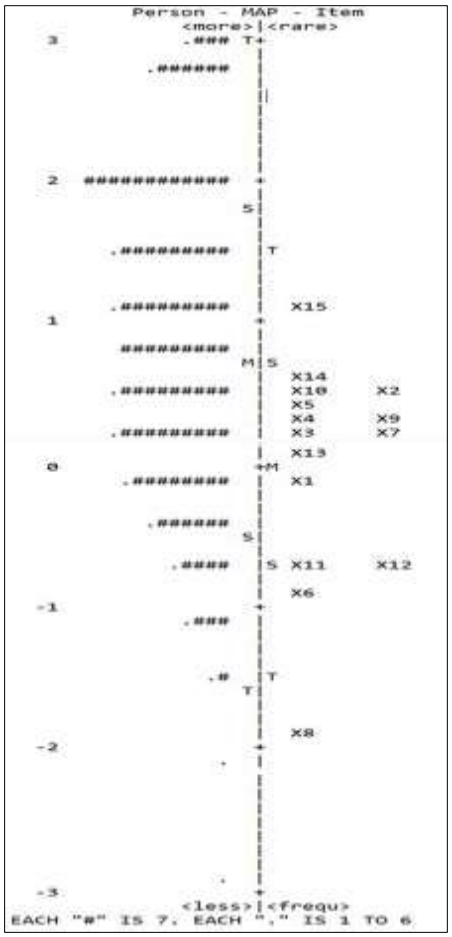


**Figure 1**. Wright Map (Person – Item Map)

The highest level of students' basic algebraic ability reached the maximum logit number, namely there were 25 people who answered all of them correctly including students in the order of 107, 126, 194, and so on with an ability logit of +3.00 logit. The student is able to answer Algebra questions well. While those who answered 14 numbers correctly were 43 students with a logit ability of +2.00 logit. Furthermore, those who answered 13 numbers correctly were 84 students with a logit ability of less than 2.00 logit. While those who were able to answer 12 numbers correctly were 68 students with an ability logit of +1.00 logit.

The students' basic algebraic ability level was the lowest and only able to answer 1 number correctly as many as 4 students with a logit ability of -1.00 logit. Likewise, the

number of correct answers between 2 to 7 is still relatively small with a logit ability of around +0.00 logit.

The average value of the logit person (0.69 logit), while the average item (0.00 logit) on the Wright map shows that the ability of all students' basic Algebraic is higher than the level of difficulty of all the algebraic questions tested.

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The average value of the logit person (0.69 logit), while the average item (0.00 logit) on the Wright map shows that the ability of all students' Algebraic concepts is higher than the level of difficulty of all the algebraic questions tested.

### 3.2. Item Analysis

The RASCH model is used to analyze the item items indicated by the output of the item measure table, the measure values in table 1 show the order of difficulty level of questions number 1 to 15, question 15 with the highest level of difficulty (1.08 logit), then questions 14,2 , and 10 have a difficulty level range (+0.5 logit) and questions with a difficulty level range (+0.2 logit) are at numbers 4, 3, and 7. Finally, the items are at the lowest level of difficulty, namely (-1,92 logit) is at number 8. The responses given by students to each question tested can be seen in the total score column in table 1.

**Table 1**. Item Measures

Item STATISTICS: MEASURE ORDER

| ENTRY NUMBER | TOTAL SCORE | TOTAL COUNT | MEASURE | MODEL S.E. | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD | PT-MEASURE CORR. | PT-MEASURE EXP. | EXACT MATCH OBS% | EXACT MATCH EXP% | Item |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 296 | 662 | 1.08 | .09 | 1.00 | .0 | 1.06 | 1.0 | .49 | .49 | 68.3 | 70.7 | X15 |
| 14 | 360 | 662 | .56 | .09 | .97 | -.8 | .97 | -.5 | .50 | .48 | 72.5 | 69.9 | X14 |
| 2 | 367 | 662 | .51 | .09 | 1.08 | 2.2 | 1.13 | 2.4 | .42 | .48 | 66.7 | 69.9 | X2 |
| 10 | 367 | 662 | .51 | .09 | 1.09 | 2.5 | 1.09 | 1.7 | .42 | .48 | 65.8 | 69.9 | X10 |
| 5 | 375 | 662 | .44 | .09 | .96 | -1.2 | .96 | -.8 | .50 | .48 | 73.5 | 70.0 | X5 |
| 9 | 390 | 662 | .32 | .09 | 1.22 | 5.5 | 1.33 | 5.4 | .32 | .47 | 63.9 | 70.4 | X9 |
| 4 | 396 | 662 | .27 | .09 | .90 | -2.7 | .84 | -2.9 | .54 | .47 | 72.7 | 70.5 | X4 |
| 3 | 400 | 662 | .24 | .09 | 1.00 | .1 | .98 | -.2 | .47 | .47 | 70.8 | 70.6 | X3 |
| 7 | 400 | 662 | .24 | .09 | .88 | -3.4 | .86 | -2.6 | .55 | .47 | 75.5 | 70.6 | X7 |
| 13 | 411 | 662 | .15 | .09 | 1.01 | .4 | 1.03 | .6 | .45 | .46 | 69.4 | 70.9 | X13 |
| 1 | 446 | 662 | -.15 | .09 | .93 | -1.6 | .90 | -1.4 | .49 | .45 | 75.2 | 72.9 | X1 |
| 11 | 500 | 662 | -.65 | .10 | .95 | -.9 | .89 | -1.2 | .45 | .41 | 78.5 | 77.6 | X11 |
| 12 | 501 | 662 | -.66 | .10 | 1.01 | .2 | 1.06 | .7 | .40 | .41 | 78.6 | 77.7 | X12 |
| 6 | 527 | 662 | -.94 | .11 | .99 | -.2 | .89 | -1.0 | .40 | .39 | 81.8 | 80.7 | X6 |
| 8 | 595 | 662 | -1.92 | .14 | .93 | -.7 | 1.07 | .5 | .33 | .31 | 90.4 | 89.8 | X8 |
| MEAN | 422.1 | 662.0 | .00 | .10 | 1.00 | .0 | 1.01 | .1 | | | 73.6 | 73.5 | |
| S.D. | 75.1 | .0 | .73 | .01 | .08 | 2.1 | .12 | 2.0 | | | 6.7 | 5.5 | |

In this study there were 662 respondents with a total of 15 items. From the results of the item analysis, it shows that the difficulty level criteria are divided into five categories. Items are categorized as easy if they have a b value close to -2.00 logit , items are categorized as moderate if -1.00 logit <b < +1.00 logit and items are categorized as

difficult if the b value is close to +2.00 logit. Furthermore, items with a value of b > +2.00 logit are in the very difficult category and b values < -2.00 logit are in the very easy category (Sari et al., 2021). The following table 1 column 4 shows the difficulty level of the item. Based on table 1, it is found that all items fall into the moderate category, except item number 8, which is the easy category**.**

### 3.3. Differential Item Functioning (DIF) Analysis

Analysis of differential item functions or Differential Item Functioning (DIF) really needs to be done to prevent fraud in certain groups. Good test items will provide accurate information from the test results. In this case, the item does not benefit one particular group, so the item is accurate in measuring the respondent's ability data (Rustam et al., 2019). Following are the results of the Differential Item Functioning (DIF) analysis

**Table 2**. DIF class specifications

| Person CLASSES | SUMMARY DIF CHI-SQUARE | D.F. | PROB. | BETWEEN-CLASS MEAN-SQUARE | t=ZSTD | Item Number | Name |
|---|---|---|---|---|---|---|---|
| 2 | .1110 | 1 | .7390 | .0556 | -.8404 | 1 | X1 |
| 2 | .0000 | 1 | 1.0000 | .0121 | -1.1626 | 2 | X2 |
| 2 | .0860 | 1 | .7693 | .0430 | -.9065 | 3 | X3 |
| 2 | .3819 | 1 | .5366 | .1913 | -.4276 | 4 | X4 |
| 2 | 1.1255 | 1 | .2887 | .5643 | .1030 | 5 | X5 |
| 2 | 3.3477 | 1 | .0673 | 1.6775 | .8706 | 6 | X6 |
| 2 | 1.4351 | 1 | .2309 | .7195 | .2510 | 7 | X7 |
| 2 | .3466 | 1 | .5560 | .1718 | -.4706 | 8 | X8 |
| 2 | .3919 | 1 | .5313 | .1963 | -.4171 | 9 | X9 |
| 2 | 1.9818 | 1 | .1592 | .9946 | .4676 | 10 | X10 |
| 2 | 9.8229 | 1 | .0017 | 4.9724 | 1.9708 | 11 | X11 |
| 2 | 13.1615 | 1 | .0003 | 6.6925 | 2.3477 | 12 | X12 |
| 2 | 2.2460 | 1 | .1340 | 1.1271 | .5577 | 13 | X13 |
| 2 | .1743 | 1 | .6763 | .0873 | -.7088 | 14 | X14 |
| 2 | .0941 | 1 | .7590 | .0471 | -.8837 | 15 | X15 |

Based on the table above, it can be seen that there are two items whose probability value is <0.05, namely numbers 11 and 12. These two items are not good at collecting data because they have the potential to benefit one of the sexes or it is said that the two items have different functions or Differential Item Functioning (DIF) occurs. Questions 11 and 12 are questions that measure the basic algebraic abilities of the Associative and Commutative Laws. Thus, the form of this question needs to be revised so that it does not benefit one sex group.

### 3.4. Student Ability Analysis

Based on the results of the RASCH modeling, students' basic algebraic abilities are shown in the person measure value, based on the MST distribution the highest student ability is 4.09 logit, namely students 107$^{th}$, 126$^{th}$, 196$^{th}$, …, totaling 24 students. The lowest students' abilities or abilities with a value of -2 .90 logit, namely students with serial numbers 433, 410, 271, and 18. Then the person (person) is said to fit the model if the MNSQ value is between 0.5 < MNSQ < 1.5 , ZSTD values are between -2 < ZSTD < 2, and Point Measure Correlation (Pt Mean Corr) values are not negative or are between 0.4 < Pt Measure Corr < 0.85 (Sari et al., 2021).

Based on the analysis of the person fit order table in the RASCH modeling, 92.74% of students had response patterns that matched the model, but there were several students

who had response patterns that did not fit the model because they did not meet the criteria for person fit indicators

### 3.5. Instrument Analysis

The overall instrument analysis in the RASCH modeling provides information about the quality of student response patterns, the quality of the instruments and the interactions between persons and items.

Table 3. Summary of 637 Measured (Non-Extreme) Persons

| | TOTAL SCORE | COUNT | MEASURE | MODEL ERROR | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD |
|---|---|---|---|---|---|---|---|---|
| MEAN | 9.4 | 15.0 | .69 | .64 | 1.00 | .1 | 1.01 | .1 |
| S.D. | 3.1 | .0 | 1.15 | .14 | .15 | .7 | .44 | .8 |
| MAX. | 14.0 | 15.0 | 2.82 | 1.07 | 1.72 | 4.1 | 7.70 | 3.7 |
| MIN. | 1.0 | 15.0 | -2.90 | .54 | .59 | -2.0 | .38 | -1.8 |
| REAL RMSE | .68 | TRUE SD | .92 | SEPARATION | 1.36 | Person RELIABILITY | | .65 |
| MODEL RMSE | .66 | TRUE SD | .94 | SEPARATION | 1.42 | Person RELIABILITY | | .67 |
| S.E. OF Person MEAN = .05 | | | | | | | | |

Table 4. Summary of 4 Measured (Non-Extreme) Items

| | TOTAL SCORE | COUNT | MEASURE | MODEL ERROR | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD |
|---|---|---|---|---|---|---|---|---|
| MEAN | 422.1 | 662.0 | .00 | .10 | 1.00 | .0 | 1.01 | .1 |
| S.D. | 75.1 | .0 | .73 | .01 | .08 | 2.1 | .12 | 2.0 |
| MAX. | 595.0 | 662.0 | 1.08 | .14 | 1.22 | 5.5 | 1.33 | 5.4 |
| MIN. | 296.0 | 662.0 | -1.92 | .09 | .88 | -3.4 | .84 | -2.9 |
| REAL RMSE | .10 | TRUE SD | .72 | SEPARATION | 7.36 | Item RELIABILITY | | .98 |
| MODEL RMSE | .10 | TRUE SD | .72 | SEPARATION | 7.45 | Item RELIABILITY | | .98 |
| S.E. OF Item MEAN = .19 | | | | | | | | |

The person measure value of 0.69 logit shows the average value of 662 students who answered the given items. The average score of students' abilities that is less than the item measure 0.00 logit indicates that students' basic algebraic abilities in solving multiple choice items about algebraic material greater than the difficulty level of the multiple choice questions given and basic algebraic abilities of students are still in the low category. As stated by Anggara and Abdillah (2022) that a high person's ability is an ability with a logit value above 0 while a low person's ability is an ability with a logit value below 0

This shows that the consistency of students' answers in solving multiple choice questions on algebraic material according to the level of difficulty is strong or good, but the quality of the items used in collecting data on students' algebraic abilities is of moderate quality. Cronbach's alpha value of 0.74 stated that the interaction between the students' algebraic abilities and the multiple choice items was overall good. Fisher (2007) states that if the person reliability value is 0.67 to 0.80, then item consistency has sufficient criteria.

The Separation value in the table aims to determine the grouping of respondents and items. The greater the Separation value, the better the quality of the instrument for all respondents and items, because it can identify groups of respondents and items (Sari et al., 2021). In the measure person table, only around 1 means that there is only one identified group and it varies, while measure item Separation values are greater than 2, meaning that the items identified are more than one group.

## 4. CONCLUSION

The results of the person analysis stated that the basic algebra ability of the students as a whole was greater than the difficulty level of the questions. The basic Algebra ability possessed by all students are higher than the difficulty level of all the algebra questions tested. This shows that the consistency of students' answers in solving multiple choice questions on algebraic material according to the level of difficulty is strong or good, but the quality of the items used in collecting data on students' algebraic abilities is of moderate quality.

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# MATH PICTURE STORY MEDIA: ITS IMPLEMENTATION ON LEARNING OUTCOMES AND MOTIVATION OF ELEMENTARY SCHOOL STUDENTS

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**ABSTRACT**

This study aims to find the effect of mathematics picture story media on elementary school students' learning outcomes and motivation. This research is a pseudo-experimental research with a post-test-only control group design. Samples were taken randomly from two elementary schools in Saparua District, namely 20 students of SDN 318 Central Maluku (experimental class) and 20 students of SD Kristen Tiouw (control class), with a total sample of 40 students. The research instruments used were the learning outcomes test and motivation questionnaire. The data were normally distributed and homogeneous based on the normality and homogeneity test results. The data obtained were analyzed using a t-test with a t-value of 3.429 > 2.864 t table and sign. 0.020 (α< 0,05). The analysis results showed a significant difference in the mathematics learning outcomes of students taught with and without picture story media. At the same time, there is no difference in the learning motivation of students taught with and without picture story media. So there is a significant influence of picture story media on mathematics learning outcomes and student motivation. Another factor that affects student motivation is creating fun learning.



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## 1. INTRODUCTION

Education plays an important role in preparing quality human resources. Education as one of the places to improve the quality of human resources is carried out through

learning. Learning is expected to provide maturity to each individual. According to Jamaris (2013), education is an effort that is made consciously in order to guide and direct the development of children towards adulthood. So that through education is able to prepare human resources of higher quality and develop each individual towards maturity towards maturity.

The development of education today has been affected by technological developments. To compensate for the impact of this technology, it is hoped that teachers will be able to provide learning that is interactive, inspiring, fun, challenging, motivates students to actively participate, and provides sufficient space for initiative, creativity and independence according to the talents, interests and physical development of students and psychological students. In order for students to be more motivated during the learning process, learning media can be provided that can provide an interesting learning. Currently, teachers are required to teach more creatively and not be boring. To create this, teachers must be good at innovating in the use of appropriate methods in learning. Unfortunately, currently the variety of methods in learning, especially in math learning, is still rarely done by teachers. In addition, teachers need learning media as part of teaching aids. Now is the time for teachers to make better changes and invite students to participate actively to be able to compete, both individually and in groups. The use of learning media is one way to increase interest in learning, the selection of media is adjusted to the conditions of students and close to students.

Various models, strategies, techniques and learning media can be used by teachers to improve student learning outcomes, both cognitive, affective and psychomotor domains. In the learning process, communication and interaction between teachers and students require a learning medium. Especially in learning mathematics which is abstract and requires reasoning. The use of learning media as a teaching aid can provide a more concrete understanding to students, by means of understanding in the form of combining the various senses possessed by students, students can absorb more material conveyed through the media(Nugraheni, 2017).

Based on the reality in the field, there are things that are not as expected based on the results of observations and interviews conducted by researchers with elementary school teachers in Saparua sub-district. In some of these schools the following results were obtained: the results of observations made by researchers obtained four things, namely first there are many students who are not active in teaching and learning activities and are only busy playing alone, talking to each other with their friends and disturbing their friends without paying attention to the explanation from the teacher and it is done during math learning. Second, the learning process still uses the lecture and question and answer method, this tends to place the teacher as the center (teacher-centered learning). Third, not utilizing appropriate and effective media in learning mathematics. Fourth, the learning outcomes of students are less than optimal in learning mathematics, this is stated by the average UTS semester 2 grade IV elementary school in Saparua Subdistrict for mathematics subjects is 53 not yet reaching the KKM 80.

Low student reading motivation and student motivation in learning mathematics are problems that occur today, especially for students in remote areas. If you do learning with great motivation, you will get maximum learning results too. Motivation is one of the factors that influence students in learning. Schunk, Pintrich and Meece (in Sudibyo et al., 2017) says that motivation has a relationship with learning ability. Motivation greatly affects students' learning. Jamaris (2013) says that motivation is a force or energy that makes individuals move and choose to do something and direct these activities towards the goals they will achieve. A person will achieve the goals he wants if that person has strong motivation in himself. So that in the learning process with the existence of learning

motivation can produce a desire to succeed, encouragement and needs in learning and enthusiasm in learning in students. This is why motivation is very influential during the learning process because through motivation students are able to achieve the goals they want to achieve. Every learner has different motivation in terms of learning, so the task of a teacher is to be able to arouse students' learning motivation to be enthusiastic in participating in the learning process.

One of the learning media that attracts attention and can help students in motivating students is picture storybook media. Children basically like new things. It can be seen in the daily process that joking is the main activity carried out by students, even by everyone, to relieve tension. The lack of reading materials is also one of the factors that influence this. With the existence of mathematics picture story media, it is hoped that it can be a solution to the problem. Given that the main purpose of making this illustrated story media product is to overcome the lack of use of mathematics reading materials in schools, this product is expected to be a solution in the selection of effective mathematics learning media, considering that this media can increase students' interest in reading, especially in math lessons(Kusumaningtyas & Listianingsih, 2017)(Ariningsih, 2010).

One of the learning media that attracts attention and can help students in motivating students is picture storybook media. Children basically like new things. It can be seen in the daily process that joking is the main activity carried out by students, even by everyone, to relieve tension. The lack of reading materials is also one of the factors that influence this. With the existence of mathematics picture story media, it is hoped that it can be a solution to the problem. Given that the main purpose of making this illustrated story media product is to overcome the lack of use of mathematics reading materials in schools, this product is expected to be a solution in the selection of effective mathematics learning media, considering that this media can increase students' interest in reading, especially in math lessons(Fahyuni & Bandono, 2015) and improve student learning achievement (Sari & Yustiana, 2021)(Yusal et al., 2022).

**Picture 1.** Media Book Picture Story Fraction Materia

Learning media is one of the main factors that can affect student learning outcomes, because it is through media that learning messages can be conveyed in accordance with these learning objectives. To realize effectiveness in learning, it must pay attention to how the learning message is designed so that students feel interested in participating in the learning process.

Learning that if only given without any innovations when providing material will cause students to get bored during the learning process. If it is still left unchecked, it will

have an impact on the low learning motivation and cognitive learning outcomes of students, resulting in the Minimum Completion Criteria for students not reaching the predetermined target.

Mathematics learning outcomes are the achievements made by students after experiencing the mathematics teaching and learning process expressed in test results. It is expected that a student's learning outcomes can be influenced by the presentation of material using maximum learning media such as picture story media. Students' mathematics learning outcomes are the results achieved by students as a description of students' mastery of knowledge or skills in learning mathematics expressed in the form of values after being tested by educators on students. In other words, mathematics learning outcomes are the results achieved by students after experiencing the mathematics teaching and learning process which is expressed in the test results.

From some of these descriptions, it can be concluded that learning outcomes are the results of students' learning efforts that have been achieved by students which include the cognitive domain or knowledge after doing something they learn in the learning process activities. Cognitive learning outcomes can be used as an indicator of success in the teaching and learning process obtained from the results of evaluations carried out during or after activities The problems previously described require solutions to improve the quality of mathematics learning. Based on these problems, the author is encouraged to conduct experiments on the effect of picture story media on learning outcomes and student motivation in learning mathematics of Saparua fourth grade students.

## 2. METHOD

This type of research is a quasi-experiment (pseudo-experiment) which is intended to see the effects of a treatment. This research is said to be a pseudo experiment because it does not control all external variables that affect the implementation of the experiment.

The research was conducted at SDN 318 Central Maluku and SD Kristen Tiouw in Class IV Odd Semester of the 2022/2023 academic year in September - October 2022. The population in this study were all elementary schools in Saparua sub-district. The samples taken were fourth grade students of SDN 318 Central Maluku and SD Kristen Tiouw. Sampling was determined by cluster random sampling technique. So that a sample of 40 students was obtained.

The independent variable in this study is mathematics picture story media. The picture story media used in this study used picture storybooks developed by the researchers themselves. The dependent variables in this study are learning outcomes and student motivation in learning mathematics. The instrument used to assess students' mathematics learning outcomes uses a test while in assessing student motivation is to use a questionnaire with a scale of 5.

### 2.1 Data Analysis Techniques

#### Data Description

The data description stage includes tabulating data for each variable, sorting the data by intervals and arranging them in the form of a frequency distribution table, finding the median, average (mean), and standard deviation.

The values that have been obtained from the known learning outcomes test are classified according to the five-scale value conversion table in the benchmark assessment approach as presented in the following table.

**Table 1.** Classification of Conversion of Learning Outcome Test Scores

| Categori | Interval |
|---|---|
| Very High | $x \geq 90$ |
| High | $75 \leq x < 90$ |
| Medium | $60 \leq x < 75$ |
| Low | $40 \leq x < 60$ |
| Very Low | $x < 40$ |

(Ratumanan & Laurens, 2015)

**Prerequisite Test Analysis**

The analysis prerequisite test in this study uses the normality test with the Liliefors test which is calculated with the help of SPSS 26.0. Data is said to be normally distributed if the significant value is> 0.05, while it is said to be not normally distributed if the significant value is < 0.05. The homogeneity test was conducted with the Two Group Variance Test (F test). If F count < from F table, then the data is homogeneous, while if F calculate > F table then the data is said to be inhomogeneous / heterogeneous.

Variance Formula

$$S_x^2 = \sqrt{\frac{n.\sum X^2 - (\sum X)^2}{n(n-1)}}$$

Formula F Calculate

$$F = \frac{S_{max}}{S_{min}}$$

**Hypothesis Test**

In the Hypothesis test in this study using the Equality of Two Averages test or the T test was used to compare the Experimental Class and Control Class Mathematics Learning Outcomes data as well as the Experimental Class and Control Class Learning Motivation. The t test formula used to test the comparative hypothesis of two independent samples is *Separated Variance*

$$t' = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^2 + s_2^2}{n_1 + n_2}}}$$

**Steps of t test**

The testing steps are as follows (Sudjana, 2012)

a. Calculating the average value $\bar{x}$ and variance ($s^2$) every sample
b. Calculating the t value with the formula *separated varians*.
   Comparison of Mathematics Learning Outcomes and Student Motivation with and without using Picture Story Media.

c. Determine the t value on the t distribution table with a significant level of $\propto = 5\%$ with $d_k = (n_1 + n_2 - 2)$.
d. Determine the test criteria if $-t_{tabel} \leq t_{hitung} \leq t_{tabel}$ then $H_0$ is accepted and $H_a$ is rejected.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

**Analysis of Student Mathematics Learning Outcomes**

Based on the results of descriptive statistical data analysis as shown in table 1, the highest posttest result achieved by students in the Experimental class group, namely SDN 318 Maluku Tengah is 73.50 with a standard deviation of 10.880. While the test results of mathematics learning outcomes achieved by students in the control class, namely SD Kristen Tiouw, were 63.60 with a standard deviation of 14.663. The average value of learning outcomes in the Experiment class and control class are both in the medium category.

**Table 2.** Descriptive Analysis of Learning Outcomes in Experimental and Control Classes

| Description | Experiment Class | Control Class |
|---|---|---|
| Mean | 73,50 | 63,60 |
| Mediandi | 76,00 | 59,50 |
| Standard Deviation | 10,880 | 14,663 |
| Variants | 118,368 | 214,989 |
| Minimum Score | 48 | 36 |
| Maximum Score | 89 | 88 |
| Number of Learners | 20 | 20 |

**Table 3**. Category of Math Learning Outcomes

| Category | Value | Total number of students | |
|---|---|---|---|
| | | Experiment Class | Control Class |
| Very High | $x \geq 90$ | - | - |
| High | $75 \leq x < 90$ | 11 | 5 |
| Medium | $60 \leq x < 75$ | 7 | 5 |
| Low | $40 \leq x < 60$ | 2 | 9 |
| Very Low | $x < 40$ | - | 1 |

Based on Table 3. It was found that there were no students in both classes who scored in the very high category. Then for the high category in the experimental class as many as 11 students and the control class as many as 5 students. The medium category in the experimental class was 7 students and the control class was 5 students. As for the very low category in the experimental class as many as 2 students and the control class as many as 9 students. As well as a very low category for no students in the experimental class and in the control class as many as 1 student.

**Student Motivation Analysis**

Based on the results of descriptive statistical data analysis as shown in table 4, the highest test results achieved by students in the control class, SD Kristen Tiouw were 85.85 with a standard deviation of 9.138 while the results of learning motivation achieved by students in the experimental class, namely SDN 318 Maluku Tengah, were 85.65 with a standard deviation of 7.058.

**Table 4.** Results of Descriptive Analysis of Learning Motivation in Experimental Classes and Control Classes

| Description | Experiment Class | Control Class |
|---|---|---|
| Mean | 85,65 | 85,85 |
| Median | 87,00 | 88,50 |
| Standard Deviation | 7,058 | 9,138 |
| Variants | 49,818 | 83,503 |
| Minimum Score | 67 | 62 |
| Maximum Score | 97 | 99 |
| Number of Learners | 20 | 20 |

**Normality Test**

The normality test in this study used the Liliefors test. Testing is carried out at a significance of 0.05 or 5% so that the criteria are declared normally distributed if the significance value > 0.05 in other words $H_0$ if the data is normally distributed, and vice versa the significance value < 0.05 Ha if the data is not normally distributed. (Ghozali, 2011).

**Table 5.** Normality Test Results

| Variable | Liliefors Significance | |
|---|---|---|
| | Experiment Class | Control Class |
| Learning outcomes | 0,200 | 0,200 |
| Student Motivation | 0,200 | 0,109 |

Based on the results of the normality test, it shows that the data on learning outcomes and student motivation have a significance value of 0.200 for the Experiment group learning outcomes and 0.200 for the control group, while 0.200 for the Experiment class learning motivation and 0.109 for the control class which is greater than the specified alpha value of 5% (0.05) which means $H_0$ is accepted and Ha is rejected. Based on the comparison of the significance value with the alpha value, it can be concluded that the data on learning outcomes and student motivation are normally distributed.

**Homogeneity Test**

The Homogeneity Test used in this study is the Two Group Variance Test (F Test). If F calculate < from F table, then the data is homogeneous, whereas if F calculate > F table then the data is said to be inhomogeneous/heterogeneous.

**Table 6.** Homogeneity Test Results with F Test

| Dependent Variable | F calculate | F table | Sign. |
|---|---|---|---|
| Learning outcomes | 1,816 | 2,168 | 0,099 |
| Student Motivation | 1,676 | 2,137 | 0,293 |

Table 6. shows that the value of F calculate < F Table means that the data of Mathematics Learning Outcomes of Experimental Classes and control classes are homogeneous with a significant value of 0.099 > 0.05. While the value of F calculate < F Table data Learning Motivation Experimental Class and control class including homogeneous with a significant value of 0.293 > 0.05. So it can be concluded that all variables have the same variant (homogeneous).

**Results of Hypothesis Test**

Prerequisite testing of the analysis shows that the distribution of the data obtained has been normally distributed and homogeneous, then proceed to hypothesis testing using:

**Two Mean Equality Test (t test)**

The analysis for hypothesis testing was carried out using the Comparison Test, namely the two-sample t test used to compare (distinguish) whether the two data (variables) were the same or different which was calculated with the help of SPSS 26.0. This test was conducted to determine whether there were differences in learning outcomes and motivation of students taught with picture story media and those without picture story media.

Based on the results of the calculation, for the Mathematics Learning Outcomes Test of Experimental and control class students, t calculate = 3.429 and t table = 2.425 at the significance level $\propto$ = 5% with a significant value of 0.020 and degrees of freedom df = 38. Meanwhile, for Student Motivation of Experimental and control classes, t calculate -0.109 and t table -0.77 with a significant value of 0.939 and degrees of freedom df = 38 as found in the following table.

**Table 7.** Results of Calculation with *t test*

| Test | T calculate | T table | df | Sign. |
|---|---|---|---|---|
| Learning outcomes | 3,429 | 2,864 | 38 | 0,020 |
| Student Motivation | - 0,109 | - 0,77 | 38 | 0,939 |

Table 7. shows that the t value is 3,429 > 2,864 t table and t calculate 3,429 > -2,864 (– t table) then $H_0$ is rejected and Ha accepted with a significant value 0,020 < 0,05. So it can be concluded that there is a significant difference between the learning outcomes of students in the experimental class and the control class. While in the learning motivation of experimental and control class students, the value of t calculate -0,109 < -0,77 t table and t calculate - 0,109 < 0,77 (–t table) then $H_0$ accepted and Ha rejected with a significant value 0,939 > 0,05 means that there is no difference in the learning motivation of experimental and control class students so that it can be concluded that mathematics picture story media has a significant effect on mathematics learning outcomes and motivation of grade 4 elementary school students in Saparua.

### 3.2. Discussion

By using picture storybooks, there is a positive and significant effect on student learning outcomes and motivation which shows student activeness in the process of using

picture storybooks and student learning outcomes increase. In fact, learning media is one of the important factors to improve students to be motivated in participating in the learning process, this is supported by the opinion of (Azhar, 2011) stated that learning media is a tool in the learning process that is carried out outside and inside the classroom. or in the classroom. Learning media is a learning resource component that contains instructional material in the student environment that can stimulate students to learn(Susilowati, 2019).

The use of picture storybooks can provide a motivation for students to learn, motivation has a very big influence on learning, if the teacher is not able to increase motivation, then students will not learn as well as possible, because there is no special attraction for them(Ali & Asrial, 2022). Students are lazy to learn, students do not get satisfaction from the lesson. According to (Bachri & Dewi, 2022) Learning materials that attract students' motivation are easier to learn and store because motivation adds enthusiasm for learning activities. Learning motivation is one of the psychological aspects that helps and encourages a person to achieve his goals. So motivation must exist in a person, because motivation is the basic capital to achieve goals. Thus, motivation must be the starting point of all activities. This is emphasized by Emosda (2017) that every teaching and learning process motivation in learning is very necessary and the use of picture storybooks does need to be applied to students in increasing student learning motivation.

The overall results of the study prove that this mathematical picture story media has a positive and significant effect on learning outcomes and student motivation in learning mathematics in grade IV SD in Saparua. This is in line with research conducted by (Ramadhani, 2020) which says that there is an influence between the presentation of material in the form of comic media and the presentation of material without comic media on students' mathematics learning outcomes and the mathematics learning outcomes of students who have high learning motivation and are taught with comic media are higher than without comic media. The use of illustrated story media books during the learning process can motivate students so that it can also affect math learning outcomes..

Based on the results of this study, it is found that there is a difference between the mathematics learning outcomes of students taught with picture story media and without picture story media. While student learning motivation is obtained there is no difference in the motivation of students taught with picture story media and without picture story media. Factors that affect student motivation in learning so that there are significant similarities in students taught without picture story media are different teaching factors. If you look at the research process, teachers who teach in classes without picture story media provide motivation by singing so that student motivation in learning is also high.

## 4. CONCLUSION

This study proves that there is a positive effect on learning mathematics using picture story media on student learning outcomes and motivation. Picture story media books provided by teachers in the mathematics learning process make students' math learning outcomes increase this is because students become more excited and passionate about learning because of the new innovations provided by teachers during the learning process.

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# Improving Student Mathematics Learning Outcomes with The Learning Model Cycle 5e Class VII

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**ABSTRACT** (10 PT)

This research is a Classroom Action Research that aims to find out whether The Learning Cycle 5e Model can improve mathematics learning outcomes. The subjects of this study were students of class VIIc MTS Al-Ikhlas Iwoimenda, as many as 34 students—retrieval of data with test results and observation sheets. Observation sheet data and mathematics learning achievement tests were analyzed using descriptive statistics. The results achieved after implementing the action through The Learning Cycle 5e Model for two cycles: a) the average score of learning outcomes in the first cycle was 63.10 from an ideal score of 100 and is in the excellent category. It increased in the second cycle to 78.43 from an ideal score of 100 and was in the excellent category. b) There was an increase in the percentage of observations of student activity in the first cycle of the first meeting by 41.67%, the second meeting was 66.67%, and the second cycle first meeting was 83.33%, the second meeting was 91.67%. From the research results on these data, the Learning Cycle 5e Model on operational material and properties of integer operations can improve the mathematics learning outcomes of class VIIc MTS Al-Ikhlas Iwoimenda.



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## 1. INTRODUCTION

The quality of education can refer to the quality of the process. An education is called quality if the teaching and learning process runs effectively, and students experience a meaningful learning process supported by reasonable resources (human, funding, facilities and infrastructure) (Setyawati et al., 2020). This means that logically a quality educational process will produce a quality product as well.

Implementation of learning in the classroom is one of the main tasks of the teacher. In the learning process there is often a tendency to minimize student involvement. The teacher's domination in the learning process causes the tendency of students to be more passive, so that students wait more for the teacher's presentation rather than looking for and finding the knowledge, skills or attitudes they need themselves.

Mathematics has objects that are systematic (Hasratuddin, n.d., 2008). Therefore, mathematics material is difficult for students to master and it has become a reality in the field that students' mastery of mathematics learning material is very low when compared to other subjects. Conditions like this are also an illustration of the mastery of mathematical concepts contained in MTs Al-Ikhlas Iwoimenda. The results of an initial survey with one of the Mathematics teachers at the school, that in general the condition of the results of learning mathematics from 34 class VIIc students only reached 50% who completed their studies. The average value of student learning outcomes is less than 72 which is the value of the Minimum Completeness Criteria (KKM).

If this condition is allowed to drag on without any effort to solve it, it will have an impact on the decline in students' mastery of mathematical concepts. Therefore, it is necessary to design an action to solve this problem by looking at what factors greatly influence students' lack of ability to master mathematical concepts. Basically, there are many factors that affect the high and low student learning outcomes, including the learning model used by the teacher in conveying subject matter and how the teacher's efforts to communicate the material to students.

Based on the results of the initial observations that have been made, it shows that learning mathematics at MTs Al-Ikhlas Iwoimenda uses a conventional learning model. Learning with the conventional model students only sit, listen, record, and memorize, the source of information is only from the teacher, does not emphasize concepts, and learning material pays little attention to students' abilities. The description of the learning model as above makes the class atmosphere boring because the teacher's learning activities are more active. Because the class atmosphere is boring for students, students' attention to learning material is reduced or absent altogether. This is what causes students to lack mastery of mathematical concepts, so that their learning outcomes are not satisfactory.

Based on this, the authors feel interested in applying one of the learning models as an alternative to improve mathematics learning outcomes. The learning model referred to (Budiman & Efrida Muchlis, 2019) is the Learning Cycle 5E learning model. According to the Learning Cycle 5E learning model, it can be carried out in several stages: (1) the engagement stage, namely trying to arouse students' interest in mathematics; (2) the exploration stage, namely providing opportunities for students to explore the widest possible material from various sources through group discussion activities or experiments; (3) the explanation stage, which provides broad opportunities for students to convey their ideas or ideas through classical discussion activities; (4) the elaboration stage, which invites students to apply the concepts they get by working on problem-solving questions; (5) the evaluation stage, namely evaluating student learning outcomes to determine the level of student understanding of the concepts that have been studied.

This model is expected to be very well applied in the learning process, because this learning model is a learning strategy that prioritizes collaboration between students and arouses student interest, so that students are able to explore the material presented by the teacher to achieve learning goals. So, learning activities are carried out through several stages, including the Engagement stage, the exploration stage, the explanation stage, the elaboration stage, and the evaluation stage.

### 1.1. The Model *Learning Cycle 5E.*

The Learning Cycle is a constructivist-based science learning model. This model was developed by J. Myron Atkin, Robert Karplus and the SCIS (Science Curriculum Improvement Study) group at the University of California, Berkeley, United States of America since 1967 Zollman and Rebello (Juhji, n.d., 2015). Constructivism theory views learning as a process of building knowledge bit by bit, which is then expanded through a limited context. Knowledge is not a set of facts, concepts, or rules ready to be retrieved or memorized. Humans must construct that knowledge and give meaning through real experience.

According to (Hadromi, 2011) that the learning cycle is a learning model that allows students to find their own concepts or solidify the concepts learned, prevents misconceptions from occurring, and provides opportunities for students to apply the concepts they have learned to new situations. The implementation of the Learning Cycle learning model in learning is in accordance with the constructivism view where knowledge is built on students themselves (Sumarsih, n.d., 2019).

Based on some of the opinions above, it can be concluded that Learning cycle 5e is a learning model with a constructivist approach, where the learning process is more student-centered, so that students can be more active in carrying out the learning process.

### 1.2. Learning Outcome

According to (Imelda Tumulo, 2022) suggests that learning outcomes are a result of the learning process by using measurement tools, namely in the form of tests that are arranged in a planned manner both written tests, oral tests, and action tests. Meanwhile (Siregar, et. al 2019) argues that learning outcomes are a change in individuals who learn, not only regarding knowledge, but also form skills and appreciation in the individuals who learn. Learning outcomes are the results obtained by students after following a particular subject matter in the form of quantitative and qualitative data. To see the learning outcomes conducted a study of students which aims to determine whether students have mastered a material or not. Assessment is a systematic effort developed by an educational institution aimed at ensuring the achievement of the quality of the educational process and the quality of students' abilities in accordance with predetermined goals. (Sulastri, n.d., 2017) suggests that learning outcomes can be measured in the form of changes in student behavior, namely the increasing student knowledge of something, attitudes and skills. In addition to the understanding of learning outcomes above, the author believes there are many more arguments about "learning outcomes". But most importantly, a learning outcome is obtained after the implementation of a learning process that has a specific purpose.

## 2. METHOD

This type of research uses PTK (Classroom Action Research). This research was carried out following the stages of classroom action research (Classroom Action Research). The action components are planning, acting, observing, and reflecting. Classroom Action

Research which is a form of reflective study by action actors (Iryani, n.d., 2020). Done to increase the rational maturity of the actions in carrying out the task, deepen understanding of the actions that were carried out, and improve the conditions in which the learning practices were carried out.

The subjects of this study were class VIIc students of MTs Al-Ikhlas Iwoimenda with a total of 34 students, consisting of 16 male students and 18 female students. The design in this study consists of two cycles, namely cycle 1 and cycle II, where each cycle consists of planning, implementation, observation and evaluation, and reflection. For more details, it can be seen in Figure 1 below:

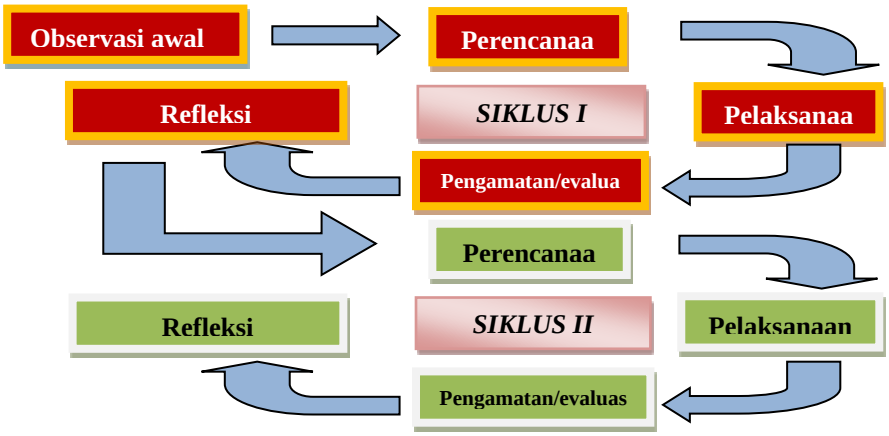


**Figure 1**. Research design

Based on Figure 1 above, in detail the design of this classroom action research is described in several stages as follows:

**1. First Observation**

The first reflection in question is to make observations in class either through observation or through the implementation of learning. Then an analysis was carried out to find problems in learning that occurred in class VII C MTs Al-Ikhlas Iwoimenda.

**2. Planning**

1) Researchers discussed, explored relevant theories, and identified learning problems, as well as determined alternative actions to overcome problems encountered in learning mathematics at school, namely the application of the 5E Learning Cycle learning model to material Operations and Properties of Integer Operations.
2) The researcher makes a learning plan or scenario according to the Learning Cycle 5E learning stages that will be determined to improve student learning outcomes in class VII C MTs Al-Ikhlas Iwoimenda.
3) Make worksheets for student activities in the implementation of learning in the classroom.
4) Developing a learning observation format/observation sheet, to see how the teaching and learning conditions in the class are when the Learning Cycle 5E learning model is applied and student learning outcomes.
5) Making a journal to find out self-reflection.

**3. Iplementation of Action**

Implementation of class action is intended as an effort to improve student learning outcomes at the level of completeness 70 in the following way:

1) Carry out the plan that has been prepared by the researcher

2) Observing student activity during core activities with observation sheets and at the end of each activity students are given a test in relation to the material being taught
3) After analyzing and reflecting on the research action, it is continued in the next cycle with the intention of improving the previous action.

**4. Observation and evaluation**

At this stage, observations are carried out on the implementation of actions using observation sheets that have been made intended to filter data in the form of student activity and observe whether the learning steps used by the teacher during learning activities are in accordance with the learning steps of the Learning Cycle 5E learning model. Evaluation is given at the end of learning activities that are intended to determine student learning outcomes.

**5. Reflection**

Reflection activities aim to analyze the data obtained at the observation stage. Weaknesses or deficiencies that occur in cycle I and will be corrected in cycle II.

The data collection technique in this study was in the form of qualitative data that was not in the form of numbers, in the form of student and teacher activity data, taken from observation sheets. and quantitative data in the form of numbers, in the form of data on student mathematics learning outcomes, taken using a learning achievement test. While the data analysis techniques using descriptive statistical techniques. as for the steps are as follows:

1. Activities during the learning process were analyzed qualitatively based on the aspects specified in the observation sheet.
2. The scoring of test results in the form of essay tests is determined by the formula:

$$\text{Test Result Value} = \frac{Number \text{ of correct answer score}}{Maksimum \text{ total score}} x100\%$$

3. Determine the average value of the test results using the formula:

$$\overline{x} = \frac{\sum_{i=1}(f_i X_i)}{\sum_{i=1} f_i};$$

with :

$\overline{x}$ : Average Value (mean)
$\sum_{i=1} f_i$ : The Number of Student
$f_i$ : Frequency
$x_i$ : Midpoint

=

4. Clasical Completeness

$$\%\ \text{Complete} = \frac{Number \text{ of correct answer completed}}{Maksimum \text{ total score}} x100\%$$

5. For qualitative data, a categorization technique with a scale of five is used based on the standard categorization set by the Ministry of National Education (Lestari et al., 2021) as follows:

**Table 1.** Categorization techniques with a scale of five

| Quantitative Value | Category |
|---|---|
| 0 – 54 | Very Low |
| 55 – 64 | Low |
| 65 – 79 | Medium |
| 80 – 89 | Hight |
| 90 – 100 | Very Hight |

## 3. RESULT AND DISCUSSION

### 3.1. Result

**Cycle I**

In Cycle I, an evaluation was carried out after completing the presentation of the material with the first two meetings presenting the material in accordance with planning, implementation of actions, observation and evaluation and reflection and the second meeting carried out planning, implementation of actions, observation and evaluation and reflection which were not carried out at the first meeting the results learning for Cycle I. The descriptive analysis of student acquisition scores after implementing learning involving The Learning Cycle 5e Learning Model on operational material and the properties of integer operations is as follows:

**Table 2.** Statistical Scores of Student Test Results in Cycle I

| Statistic | Statistic Value |
|---|---|
| Subject | 34 |
| Ideal Score | 100 |
| Average Score | 63,10 |
| Highest Score | 81,48 |
| Lowest Score | 36,90 |

Based on the table above, it shows that the average score of mathematics learning outcomes after applying learning that involves the Learning Cycle 5e learning model on Integer Operations Material for Class VIIc MTs Al-Ikhlas Iwoimenda the ideal score that may be achieved is 100. Meanwhile, individually the score achieved students in this application with the highest score of 81.48 and the lowest score of 36.90 of the highest possible score of 100 and the lowest possible score of 0. After the student test scores are grouped into five categories, the frequency and percentage distributions are obtained in table 3.

**Table 3.** Frequency Distribution and Percentage of Test Scores in Cycle I

| Score Interval | Category | Frekuency | Percentage (%) |
|---|---|---|---|
| 0 – 54 | Very Low | 11 | 32,35 |
| 55 – 64 | Low | 6 | 17,65 |
| 65 – 79 | Medium | 16 | 47,06 |
| 80 – 89 | Hight | 1 | 2,94 |
| 90 – 100 | Very Hight | - | - |
| Amount | | 34 | 100% |

Based on the table above shows that there are 32.35% of students who are in the very low category, 17.65% of students are in the low category, 47.06% are in the medium category, are in the high category, and 0% of student learning outcomes are in very high category. This shows that the ability level of students is still lacking. Besides that, according to the average score of the test results in Cycle I, it was 63.10. If converted into a scale of five it is in the low category. This means that the average score of class VIIc student achievement at MTs Al-Ikhlas Iwoimenda after the application of learning involving The Learning Cycle 5e Learning Model on Integer Operations Material is in the sufficient category.

To see the percentage of mathematics learning completeness of Class VIIc MTs Al-Ikhlas Iwoimenda after the implementation of The Learning Cycle 5e on Integer Operations material cycle I can be seen in Figure 2 below:

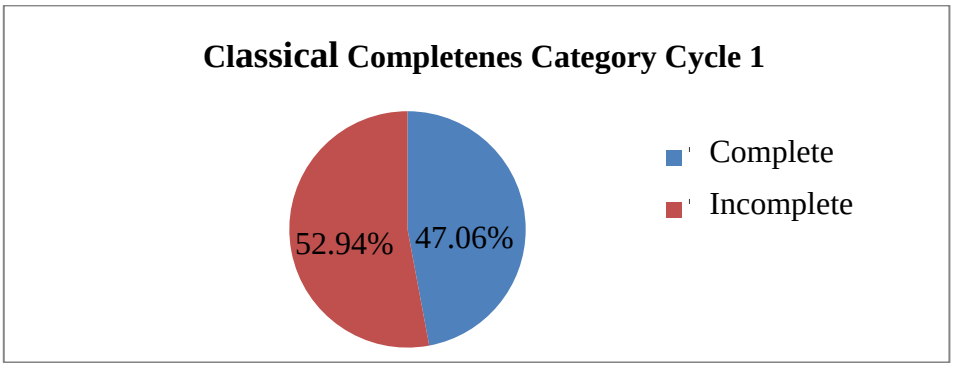


**Figure 2.** Classical completeness Cycle I

Based on the diagram, it can be seen that of the 34 students, there were 18 students or 52.94% whose mathematics learning outcomes were in the incomplete category, while those in the completed category were 16 students or 47.06% meaning that more students had learning outcomes. the mathematics is in the incomplete category.

Based on the results of observations on the implementation of cycle I actions, it was found that the learning outcomes with the level of completeness achieved by students had not yet reached the predetermined work indicators. Problems that arise during learning and result in not achieving classical completeness in cycle I include:

1. The teacher has not been able to organize time properly, so there is no time to give students the opportunity to ask questions that they do not understand.
2. The teacher has not been able to guide students to make learning conclusions according to the learning objectives, so that students are still lacking in concluding learning.

Based on the problems above, for the meeting in cycle II the researcher formulated corrective actions as an alternative problem solving described as follows:

1. The teacher provides clearer time limits for each student activity during the learning process so that all student activities can be carried out optimally so that the management of teacher learning includes giving students the opportunity to ask questions about things that are not yet understood, can be implemented.
2. The teacher must be able to guide students to make learning conclusions according to the learning objectives, so that students are still lacking in concluding learning.

**Cycle II**

Analysis of student learning outcomes scores after applying The Learning Cycle 5e Learning Model to Cycle II Integer Operation Material can be seen in the table 4.

**Table 4.** Statistics of Student Test Scores in Cycle II

| Statistic | Statistic Value |
|---|---|
| Subject | 34 |
| Ideal Score | 100 |
| Average Score | 78,43 |
| Highest Score | 96,29 |
| Lowest Score | 41,58 |

Based on the table above, the average score of mathematics learning outcomes after applying learning that involves the Learning Cycle 5e learning model on Integer Operations Class VIIc MTs Al-Ikhlas Iwoimenda the ideal score achieved is 100. Meanwhile, individually the score achieved by students on application this with the highest score of 96.29 and the lowest score of 41.58 from the highest score reached 100 and the lowest score reached 0. After the student test scores are grouped into five categories, the frequency and percentage distributions are obtained as follows:

**Table 5.** Frequency Distribution and Percentage of Test Scores in Cycle II

| Score Interval | Category | Frekuency | Persentage (%) |
|---|---|---|---|
| 0 – 54 | Very Low | 1 | 2,94 |
| 55 – 64 | Low | 3 | 8,82 |
| 65 – 79 | Medium | 13 | 38,24 |
| 80 – 89 | Hight | 13 | 38,24 |
| 90 – 100 | Very Hight | 4 | 11,76 |
| Amount | | 34 | 100% |

Based on the table above shows that 2.94% of students are in the very low category, 8.62% of students are in the low category, 38.24% are in the medium category, 38.24% of students are in the high category, and 11.76 % of student learning outcomes are in the very high category. This shows that the level of student ability has increased. Besides that, according to the average score of the test results in Cycle II, which is equal to 78.43 if converted to a scale of five, it is in the medium category.

To see the percentage of mathematics learning completeness of Class VIIc MTs Al-Ikhlas Iwoimenda scores after the implementation of The Learning Cycle 5e on Integer Operation Material in cycle II can be seen in Figure 3.

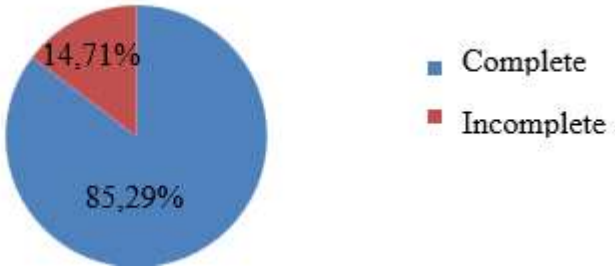


**Figure 3.** Classical completeness Cycle II

Based on Figure 3 above, it can be seen that of the 34 students there were 5 students or 14.71% whose mathematics learning outcomes were in the incomplete category, while those in the complete category were 29 students or 85.29%, meaning that there were more students whose mathematics learning outcomes are in the complete category.

Based on the results of the descriptive analysis above, it shows that the learning outcomes of Class VIIc students of MTs Al-Ikhlas Iwoimenda after the implementation of The Learning Cycle 5e Learning Model on material Operations and Properties of Integer Operations. This is said by looking at the increase in the average score obtained by students from 63.10 in Cycle I to 78.43 in Cycle II.

### 3.2. Discussion

Based on the results of the research that has been analyzed, it can be seen that the results of student evaluations after giving the questions completed have increased. This can be seen from the increase in the average score of students during this research, this means that the method applied is able to improve student learning outcomes, and there are fewer students who get low scores. The average score of student learning outcomes when converted into a scale of five categories is in the high category which was initially in the sufficient category. This shows that students' mathematics learning outcomes are increasing.

This research was declared successful after carrying out cycle II because it had achieved the predetermined performance indicators. After cycle II, students' scores increased with an average score of 78.43 with classical learning mastery of 85.29%, while in cycle I students were only able to obtain an average score of 63.10 with classical completeness of 47.06%. Based on the results of observation and evaluation, the research was stopped in cycle II, because the indicators of the success of this research had been achieved by achieving a performance indicator of 75% in this study, namely 85.29%, which was said to be complete.

The application of The Learning Cycle 5e Model to material on Integer Operations can cause students to stop being lazy. In this way students can also concentrate more on paying attention to lessons and be active in participating in the teaching and learning process in class because it can make it easier for them to solve the problems given, if the material is understood. In addition, it can make students and their friends have a desire to study together if they experience difficulties in learning.

Based on this description, it can be concluded that, "The Application of The Learning Cycle 5e Learning Model on Operational Materials and Properties of Integer Operations can improve mathematics learning outcomes in students of class VIIc MTS Al-Ikhlas Iwoimenda".

## 4. CONCLUSSION

Based on the results of the analysis of several cycles and discussion, it can be concluded that the implementation of learning through the application of The Learning Cycle 5e Learning Model can improve student learning outcomes for Class VIIc MTS Al-Ikhlas Iwoimenda. 2017/2018 Academic Year in material Operations and Properties of Integer Operations.

This is illustrated by the increase in student learning outcomes obtained from the results of the action tests for each cycle shown from the results of the evaluation of cycle I actions, classical completeness has not been achieved, namely 47.06% or as many as 18 students who did not complete out of 34 students who received a score of 72 with a score

average 63.10. Because the test scores for cycle I had not yet reached the indicator of success, it was continued until cycle II. From the results of the evaluation of the second cycle test, it was obtained that classical completeness was 85.29% or as many as 29 students with a complete score of 34 students who scored ≥ 72 with an average score of 78.43. ≥ 75% of students have scored ≥ 73.

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# THE EFFECTIVENESS OF THE *TGT* LEARNING MODEL ON LEARNING OUTCOMES ON THE MATERIAL OF RATIONALIZING THE DENOMINATOR OF ROOT FORM

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**ABSTRACT**

Team Games Tournament (TGT) learning is well prepared with the proper procedures. It will be better than conventional methods, such as lectures that tend to be monotonous. This encourages researchers to conduct research with the title "The Effectiveness of the Team Games Tournament (TGT) Learning Model on Mathematics Learning Outcomes on the Material of Rationalizing Denominators of Root Forms." This study aims to analyze the effect of mathematics learning outcomes of class X IPA 1 MAN 1 Tasikmalaya City on the material of rationalizing the denominator of the root form presented with the Teams Games Tournament (TGT) learning model. The type of research used is pseudo-experiment research. Data collection techniques are done by observation and giving instruments in the form of pre-test and post-test questions and minute papers. The sample was taken with a purposive sampling technique so that 15 students were obtained as research subjects. Before conducting hypothesis testing, data requirements were first tested, including normality testing using SPSS 25 with the Shapiro-Wilk Test and homogeneity testing using SPSS 25 with the Shapiro-Wilk Test. Hypothesis testing using the t-test. The results of this study indicate that student learning outcomes in the material rationalize the denominator of the root form by using the Teams Games Tournament (TGT) learning model. There is a difference between the pre-test and post-test results.



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## 1. INTRODUCTION

Mathematics is one of the branches of science that acts as a subject that is a milestone in the progress of science and technology. Mathematics is an essential science because it is related to everyday life (Afriansyah, 2014; Apiati et al., 2019). Realizing this meaning, learning outcomes, especially mathematics subject matter, need attention (Ma'ruf et al., 2019; Rahayu & Afriansyah, 2014). Success in math subjects depends on various factors, including the students themselves, the subject, teachers and parents, and the teacher's teaching and learning strategies. Another factor that makes mathematics less interesting for students is that the approach teachers use in learning makes students bored and divert their attention outside of learning mathematics. Many students consider Mathematics as one of the most challenging subjects. They see Mathematics as uninteresting, difficult to learn, confusing, boring, and has no direct connection to everyday life. Students often only view Mathematics as procedural rules that must be memorized (Hariyani, 2018).

The teacher's routine is explaining, giving example problems, and giving exercises. Activities in learning are only one-way, without communication between students and teachers in solving existing math problems. The solution that teachers can do to overcome these problems is to change the learning model that will be applied. The learning model to be used is a model that can change students from passive to active. One of the learning models that involve students actively gaining the ability to learn mathematics and understand mathematical concepts correctly is the cooperative model.

The cooperative learning model is one of the learning models that can make students responsible and interested in participating in math lessons (Pirdaus & Afriansyah, 2016). The cooperative learning model is believed to help students understand complex concepts and helps foster awareness of critical thinking, cooperation, and helping friends. This is in line with the (Supriatna & Afriansyah, 2018) that through the application of cooperative learning models, cooperation between teachers and students can be improved so that students can better understand mathematical concepts. Luritawaty's (2018) opinion states that to overcome the problem of understanding mathematical concepts, cooperation between educators and students needs to be improved in the learning process.

In this case, the teams games tournament (TGT) cooperative learning model is considered capable of making students in a positive cooperative situation so as to increase team cohesiveness and each student is responsible for learning the lesson content. The TGT learning model can be easily implemented by teachers in the classroom, involving students as peer tutors. This model allows active participation of all students who have diversity (Yasa, 2014).

Some research related to the Teams Games Tournament (TGT) learning model shows positive results on learning outcomes, namely research conducted by (Asmawati et al., 2022) on the effectiveness of mathematics learning through the application of the teams games tournament (TGT) type cooperative model; (Amin & Suardiman, 2016) on differences in students' mathematics learning achievement in terms of learning styles and learning models; (Solihah, 2016) on the effect of the teams games tournament learning model on math learning outcomes; (Ernada et al., 2021) on the effectiveness of the teams games tournament learning model, 2021) on the effectiveness of the teams games tournaments learning model with ludo media on the mathematics learning outcomes of tiara bangsa batam college students; (Sofyan, 2022) on the effectiveness of the teams games tournament type cooperative learning model to improve learning outcomes. Some of these studies have in common with this study, namely both measuring the effectiveness of the teams games tournament model.

However, what makes it different is the research location, MAN 1 Tasikmalaya City, which is a new school and has never been studied about the teams games tournament (TGT) model.

This study was conducted with the aim of investigating the impact of the application of the Team Games Tournament (TGT) type cooperative learning model on students' mathematics learning outcomes, in connection with the problems previously described. The researcher hopes that the use of the TGT type cooperative learning model will have a positive influence on students of class X IPA 1 MAN 1 Tasikmalaya City on the material of rationalizing the denominator of the root form.

## 2. METHOD

The type of research used is experimental research (pseudo-experiment). The research method to be applied is quantitative research with a pseudo-experimental approach. The research design used is a pre-test and a post-test. The sample determination was carried out by purposive sample, namely students of class X IPA 1 MAN 1 Tasikmalaya City consisting of 15 students. By giving a pre-test question with as many as two questions. Researchers then conducted learning with the Team Games Tournament (TGT) model to students, then conducted a post-test to measure student learning outcomes. Data collection techniques are carried out by observation and giving instruments pre-test, pot-test questions, and unstructured interviews.

To process quantitative data, data processing techniques are processed using the SPSS Statistics 25 computer program carried out with the following steps:

a. Data entry into SPSS Worksheet
b. Data analysis with 95% confidence level
c. Data analysis is carried out to test the hypothesis that has been formulated to draw conclusions.

## 3. RESULTS AND DISCUSSION

In this study, the sampling technique used is purposive sampling. The sample is taken using purposive technique with spesific considerations or criteria. According to Rijal & Sofiarini (Nurmi et al., 2020), the data analysis technique using purposive sampling with one group pretest-postest design can utilize inferential statistics with a two way t-test, statistics parametric. The initial step before conducting parametrec statistics is to perform test of normality and homogeneity (Sugiyono, 2016).

Description of research data in the form of pre-test and post-test results using the TGT model as follows:

1) The data of students learning test results, both pre-test and post-test, who were taught using the TGT model comprehensively, can be seen in the table 1.

**Tabel 1.** Recapitulation of Students Mathematics Learning Test Result

| | **Pre-Test** | **Post-Test** |
|---|---|---|
| Min | 55 | 75 |
| Max | 100 | 100 |
| Mean | 80.67 | 89.53 |
| Median | 80 | 90 |
| Range | 45 | 25 |
| Standard Deviation | 13.48 | 8.04 |

2) Normality and Homogeneity Test of Pre-test and Post-test
Normality Test of Pre-test and Post-test

Based on the results of the normality test with SPSS, the Sig value of the students' pre-test with the Shapiro Wilk Test, obtained ( 0.191) is above 0.05, thus $H_0$ is accepted and $H_1$ is rejected, meaning that the data comes from a normally distributed population. While the post-test of students with the Kolmogorov-Smirnov Test and the Shapiro Wilk Test, obtained (0.208) are above 0.05, thus $H_0$ is accepted and $H_1$ is rejected, meaning that the data comes from a normally distributed population.

3) Homogeneity Test of Pre-test and Post-test

After the normality test was carried out in the class using the Teams Games Tournament (TGT) learning model, followed by the pre-test and post-test homogeneity test, the Sig value was above 0.05 so that $H_0$ was accepted and $H_1$ was rejected, meaning that the data came from a homogeneously distributed population.

$H_0$ : Data comes from a normally distributed population
$H_1$ : Data does not come from a normally distributed population

If the p-value (value in the Sig. column in the Tests of Normality table) < α, then reject $H_0$.

**Table 2.** Normality Test Results with Shapiro-Wilk Test

| | Statistic | df | Sig. |
|---|---|---|---|
| Pretest | .920 | 15 | .191 |
| Posttest | .922 | 15 | .208 |

Table 2. The results of the normality test with the Shapiro-Wilk method for the pretest variable were 0.191 (19.1%) and the posttest variable was 0.208 (20.8%), the Sig. (p-value) > 0.05. The conclusion is to accept $H_0$ (based on decision-making rules), meaning that the data comes from a nomally distributed population. The Sig value is above 0.05 so that $H_0$ is accepted and $H_1$ is rejected, meaning that the data comes from a homogeneously distributed population.

4) Hypothesis Test
To find out if there is a significant effect on learning outcomes, it is necessary to make a decision based on the T test.

**Table 3.** Pair T Test Results

| | | Mean | Std. Deviation | Std. Error Mean | 95% CI Lower | 95% CI Upper | Sig. |
|---|---|---|---|---|---|---|---|
| Pair 1 | Pretest - Posttest | -8.867 | 12.099 | 3.124 | -15.567 | -2.166 | .013 |

Based on testing the Teams Games Tournament (TGT) learning model variable on the material to rationalize the denominator of the root form has a p-value (in the Sig. column) of 0.013 such that the p-value is smaller than 0.05, so the conclusion is H_0 is rejected and H_1 is accepted, meaning that there is an influence on the Teams Games Tournament (TGT) learning model on student learning outcomes on the material to rationalize the denominator of the root form.

This study aims to determine the effectiveness of using the Team Games Tournament (TGT) learning model on learning outcomes in class X IPA 1 MAN 1 Tasikmalaya City. Based on the results of the final test that has been done, there is an increase in student learning outcomes using the Teams Games Tournament (TGT) learning model before and after learning. Before learning by using the TGT model, the average value of students was 80.67 and after learning by using the TGT model, the average value of students became 89.3 an increase of 8.63 better than before learning using TGT.

Based on the results of the study in general all students can answer questions well. This further proves that the Teams Games Tournament (TGT) learning model can improve student learning outcomes and students are more active and motivated in learning. Thus, it can be concluded that the application of the Teams Games Tournament (TGT) learning model can stimulate students' richer thinking.

## 4. CONCLUSION

Based on the results of the analysis and discussion that has been carried out, several conclusions can be drawn from this study:

1) From the student's response to the TGT learning model, from the minute paper data that has been obtained, the student's response to the Teams Games Tournament (TGT) learning model on the material of rationalizing the denominator of the root form of the student's response is excellent, this is said so because of the respondents 80% of the students agreed and felt happy with the TGT model learning model which can train students to be more active, students can learn to respect their friends' opinions by applying games in it. Thus, applying the Teams Games Tournament (TGT) learning model can provide a new atmosphere that can reduce student boredom during learning.
2) When viewed in terms of the average value of pretests and posttests using the Teams Games Tournament (TGT) learning model has increased. The average pretest result is 80.67 and after learning by using the TGT learning model the average posttest is 89.3.
3) Based on the Hypothesis Test that has been carried out testing the Teams Games Tournament (TGT) learning model variable on the material rationalizing the denominator of the root form has a p-value (in the Sig. column) of 0.013 more minor than the level of significance 0.05, meaning that there is an influence on the Teams Games Tournament (TGT) learning model on improving student learning outcomes on the material rationalizing the denominator of the root form.

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# EXPLORATION OF MATHEMATICAL OBJECTS IN THE *BALALE'* TRADITION AS AN EFFORT FOR MODULING IN THE DAYAK SALAKO CULTURE AT *NYARUMKOP*

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**ABSTRACT**

This study aims to explore mathematical objects in the *Balale'* tradition of the Dayak Salako tribe in *Nyarumkop* Village and then integrate them into the Creation of Culture-Based Modules. The research method used is the ethnographic method, and the type of research used is qualitative. The *Balale'* tradition is one of the habits of the *Nyarumkop* farmers when working the rice fields collectively and in rotation. The *Balale'* tradition aims to strengthen relations between communities, because the community works together in the fields to complete tasks such as clearing land, planting rice, clearing grass, and harvesting rice. The results of the study show that the *Balale'* tradition has a direct mathematical object in the form of facts that lie in the people who join the *lale'an* members, the concept lies in the process of working the rice fields which are carried out in turns, the principle lies in the mindset of the community in carrying it out and the skills lies in the work technique of each member of *Lale'an*. This research also contains indirect mathematical objects in the form of discipline shown by *Lale'an* members in carrying out this tradition. Then it is mathematically integrated into the creation of a culture-based SPLDV Module using mathematical concepts.



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## 1. INTRODUCTION

Education is a means that must be obtained by every human being. Education always keeps up with the times and continues to be embedded in every human life. One of the factors that make education must continue to develop is culture. Culture and education have a relationship with each other. In line with this, Normina (2017) states that through education, cultured humans can be developed, and culture can also direct individuals to always adhere to norms or laws that have been made as a standard of living. The same thing was conveyed by Rahtowo & Budiyono who stated that education and culture can produce virtuous people by preserving norms or laws that have become a way of life (Rahtwo & Budiyono, 2022).

One of the sciences attached to education and culture is mathematics. Mathematics is a comprehensive science that exists in every aspect of human life. Mathematics is part of human daily life. Therefore every activity made by each individual is inseparable from mathematics. Mathematics has an important role in solving every problem that exists in human life (Dosinaeng et al., 2020). The development of mathematics is inseparable from the culture possessed by humans.

Mathematics develops as a result of life challenges faced by humans in various regions and cultures (Rachmawati, 2012). Thus, it can be stated that mathematics is a cultural product resulting from the abstraction of human reason as a problem-solving instrument and has a close relationship with the development of local culture. Using mathematical concepts and theories, mathematics is usually applied in everyday life to calculate, reason, or solve various problems. According to Bell (Minarni et al., 2021) Mathematics has direct objects such as facts, ideas, principles, and skills, and indirect objects such as the ability to think logically, solve problems, think analytically, have a good attitude towards mathematics, be thorough, work hard , and discipline.

Culture is an aspect of everyday life that cannot be avoided because it is an integral and inseparable part of a society or group (Putri, 2017). Where, culture is a legacy of behavior which includes knowledge, beliefs, morals, laws, arts, customs, and norms. Mathematics and culture are things that cannot be avoided in everyday life.

According to E.B. Tylor, culture is the unity of human activity which includes knowledge, belief, art, morals, laws, customs, and other behaviors. However, in anthropology, culture is a unified system of actions, ideas, and human creations within the framework of the existence of a society related to humans through learning. This explains why almost all human activities are cultural because very few human actions in the context of societal life do not require acculturation. In contrast, cultural historians define culture as the heritage or traditions of a society (Rahmawati Z & Muchlian, 2019).

Each region or tribe, including the Salako Dayak, must have a unique cultural tradition. The *Balale''* tradition is one of the cultures owned by Dayak Salako which contains mathematical objects. Residents of *Nyarumkop* Village, East Singkawang District, West Kalimantan continue to carry out this tradition. Most of the Dayak people in *Nyarumkop* Village have a livelihood as rice farmers. The subsistence system is a system used by humans to fulfill their basic needs, especially for subsistence through animal husbandry and farming (Pertiwi & Budiarto, 2020). The *Balale''* tradition is one of the cultures passed down from generation to generation, and the people in *Nyarumkop* continue to practice this tradition from their ancestors in farming. Farming activities carried out by the community are rice fields.

In the *Balale''* Tradition, teaching and learning processes and strategies with values are anticipated to help students instill good attitudes and understand the mathematical objects contained therein. Students will recognize the relationship between culture and mathematics if they study mathematics that incorporates cultural elements (Dosinaeng et al., 2020).

Introducing local culture and customs that are still enforced by some groups of people will make learning more memorable. This is achieved by taking into account the mathematical skills developed by different subgroups of people and by taking into account the different approaches adopted by each culture (Prahmana & D'Ambrosio, 2020).

Ethnomatematics is the process of incorporating local culture containing mathematical objects into formal mathematics education. It is the same as opinion Shirley (Marsigit et al., 2016), that currently the ethnomathematics disciplines that emerge and develop according to local culture are at the center of the learning process and learning methodology. Educators can introduce mathematical objects to students in various ways, including by utilizing modules. The *Balale'* Tradition will be included in the SPLDV-based Module. This module is designed to make it as simple as possible for local students to understand mathematical objects. Students will find it easier to understand abstract SPLDV material if they use examples from everyday life.

TIMSS and PISA study results place Indonesia in a low ranking (below average). This is due to the lack of students' mathematical abilities in solving reasoning questions & problem solving due to the lack of giving portions of reasoning and solving problems in teaching materials and practice questions to students. In addition, the facts in society show that many students fail to get actual math scores, because they are only motivated to meet the target test scores. This results in concerns about students' inability to apply mathematics to solve problems in everyday life.

The existence of these problems provides a common thread that we should seek various alternatives and innovations in order to improve our students' mathematical abilities. One of the keys is improving the learning process in schools, especially by increasing the portion of reasoning, solving problems, arguing and communicating through teaching materials that are more contextual. Because the researcher deems it necessary to write about "Exploration of Mathematical Objects in the *Balale'* Tradition' as an Effort to Make a Module on the Culture of the Dayak Salako Tribe in *Nyarumkop*" as a special study on mathematics which is owned and practiced by the community for generations, which is expected to be a reference material contextual mathematics learning.

In order to help students do their school work, it is necessary to investigate the mathematical objects that exist in contemporary culture. Therefore, students' understanding of mathematics must be based on their daily experiences. The exploration of the *Balale'* Tradition which contains mathematical concepts is the first step and the main focus of this investigation.

Ethnomatematics in learning can help students to better understand learning mathematics and respect culture. Students will realize that mathematics is not only exact learning that only exists in schools. But learning that can be applied and utilized in everyday life even in culture.

Integrating local culture that contains mathematical objects into formal mathematics learning is by ethno-mathematics. The field of ethnomathematics that arises and develops in society according to local culture is the center of the learning process and teaching methods. There are various ways that educators can do to introduce mathematical objects to students, one of which is by using a module. Modules that will be integrated into the *Balale''* tradition are modules on SPLDV material. The module is made as well as possible to make it easier for students to understand mathematical objects in the local culture. Students will find it easier to understand abstract SPLDV material by using things that happen in everyday life. Ethnomatematics will make learning mathematics closer to everyday life because it connects mathematics with cultural elements where students grow and develop.

The purpose of this study was to find out the mathematical objects contained in the *Balale'* Tradition of the Dayak *Nyarumkop* tribe in Singkawang Timur District and to find

out the making of modules in class VIII on the material System of Two Variable Linear Equations (SPLDV) containing the mathematical objects of the *Balale'* Tradition. The research conducted is the first step in conducting development research. So that this research will be used as material for analysis and literature review to conduct further research.

This research will explore mathematical objects in the *Balale''* tradition of the Dayak Salako tribe in *Nyarumkop* Village and then integrate them into the Culture-Based Module Creations. The findings from studying the elements of the *Balale'* Tradition will be used to develop a Mathematics Module on SPLDV material that respects the socio-cultural environment and local wisdom of the community in future research.

## 2. METHOD

The methodology used in this research is ethnography. Creswell (Wijaya, 2015) suggests that, ethnography is a qualitative research method for characterizing and analyzing various cultural groups that interpret patterns of behavior, beliefs, and language that develop and are used from time to time by a group of people.

Arikunto (2016) states that the research subject is the subject intended to be investigated by the researcher. The subjects in the research conducted were members of the Salako Dayak tribe who still carry out the *Balale'* tradition in *Nyarumkop*, Singkawang Timur District, namely Mrs. Yussella (45 years) and one member of the custom community who understands the *Balale'* tradition, namely Mr. Hermanus (61 years).

According to Sugiyono (2017) The object of research is the attributes, characteristics, or values of a person, object, or activity that has been manipulated by researchers to study and draw conclusions. This research focuses on the *Balale'* Tradition which contains mathematical objects.

*Nyarumkop* Village, Singkawang City, is the location of this research. In this study the procedure was divided into three stages, namely the preparation stage, the implementation stage, and the conclusion stage. This study uses interviews, observation, and documentation to collect data. Data collection was carried out in several ways, namely observation, interviews, and documentation. The analysis carried out is to analyze the form of mathematics and classify it according to existing mathematical objects.

## 3. RESULTS AND DISCUSSION

Based on the data collected during the investigation in *Nyarumkop* Village, Singkawang City, information was obtained regarding the elements of the *Balale'* Adat. The interview which was conducted on March 19 2023 was used to collect data on 2 informants, namely one Indigenous member and one member of the community who carried out the *Balale'* Tradition. Observations began on Thursday 30 March 2023.

### 3.1. Results

The *Balale'* tradition was chosen because this culture is a culture that is carried out every year by the people in *Nyarumkop* Village, Singkawang City. This culture must be introduced early on to students. Mathematical objects such as direct mathematical objects consisting of facts, concepts, principles and skills as well as indirect mathematical objects consisting of analytical thinking abilities, thoroughness and diligence contained in this tradition need to be known by students. Integrating values in the *Balale'* Tradition in mathematics learning is expected to be able to help students instill character and understand the mathematical objects contained therein. When the values in the *Balale'* Tradition are

integrated into learning mathematics, students will better understand the meaning in learning mathematics, and can foster students' learning motivation in learning mathematics.

Before carrying out the *Balale'* Tradition, the *Balala*' traditional ritual is first carried out. This ritual is carried out with the intention of eliminating all negative influences from the agricultural process to the harvest period.

### 3.1.1. *Balala'* Traditional Rituals

The *Balala'* traditional ritual must be carried out before the *Balale'* tradition begins. This *Balala'* ritual is a ritual that is performed by abstinence. In the *Balale'* Tradition, the *Balala'* Ritual is believed to be able to ward off bad things that will happen which can cause the community to fail to harvest or produce less than optimal agriculture. This tradition is carried out by the Dayak Salako community, especially in *Nyarumkop* Village, to ask Jubata (God) for protection. The *Balala'* Traditional Ritual was carried out on March 31, 2023.

Prior to the implementation of *Balala'*, namely on March 30 2023 in the afternoon, a *Nyangahatn* will be held as part of the ritual with the aim of reading a prayer to Jubata (God) which will be performed by the traditional leader (*PeNyangahatn*). The local community, especially the men, will work together to prepare the materials to be used and clean the area around the place to be used in the *Nyangahatn* traditional ritual. The ingredients that must be prepared for this traditional ritual are 1 free-range chicken, tumpi (*cucur cake*), poe (glutinous rice), sunguh (plain rice), eggs, chicken blood, candles (companion offerings/other food offerings).

**Figure 1.** The process of preparing for the *Nyangahatn* Ritual

Nyangahantn will be held at a location determined by the traditional leader. After all the preparations are complete, the ritual will begin reading a prayer to Jubata (God).

**Figure 2.** The *Nyangahatn* Process

After the completion of the traditional *Nyangahatn* ritual, *Balala'* begins. This ritual is carried out for one day starting at 18.00 WIB and ending the next day at the same time. While *Balala'* is being carried out, people are prohibited from leaving their homes and are prohibited from receiving guests from outside until *Balala'* is finished. Every street and alley will be given a bar/sign that the *Balala'* Tradition is being carried

out and as a sign that it is forbidden to enter or leave the area. Communities who violate the rules in the *Balala'* Adat ritual will be subject to customary sanctions.

**Figure 3.** Signs/Signs of the Implementation of *Balale'*

### 3.1.2 Work System in the *Balale'* Tradition

In accordance with the *Balale''* Tradition, the rice fields are worked in turns. In the *Balale'* Tradition, group members consist of four to seven people, and whose turn is determined by whose land is available to work on and whose rice seeds can be planted. The daily work schedule in the *Balale'* Tradition starts at 06.00 and continues until 11.00, with a break from 13.00 to 17.00 WIB. For seven participants, the *Balale'* Tradition takes approximately nine hours. *Balale'* members who have received *Lale'an* are required to follow *Lale'an* in the fields of other *Balale''* members until all members have had their turn. If a member cannot attend the *Balale'* after receiving *lale'an* from another member, that member must send a replacement.

If during the implementation of the *Balale'* Tradition there are obstacles such as rain which makes it impossible to work in the fields, then the *Balale'* Tradition will be stopped and continued the next day at the same location. If the land worked on in this tradition is completed before the specified time, then the master of *lale'an* may invite other participants to return to their respective residences.

**Figure 4.** *Balale''* Tradition

## 3.2. Discussion

### 3.2.1 Mathematical Objects in *Balala'* Traditional Rituals

In the traditional *Balala'* ritual, it contains mathematical objects including direct and indirect objects. The direct mathematical objects contained in the *Balala'* customary ritual are facts, concepts, principles and skills. While the indirect object is the ability to think analytically, thoroughness and perseverance. Facts are agreements that are approved and implemented in doing something. In mathematics, facts are agreements approved by scientists, such as symbols, symbols, or rules. The concept is defined as an abstract idea that allows one to classify an object. Principle is a statement that contains the relationship between two concepts. While skill is a rule to obtain a result. For the indirect mathematical objects contained in the *Balala'* customary ritual

are the ability to think analytically, accuracy, and perseverance. In addition, the researcher also explained the steps for making culture-based Student Worksheets (LKPD) by utilizing one of the elements in the *Balale'* Tradition.

In the traditional *Balala*' ritual, the facts are found on the signs that are prohibited from entering the area that carries out *Balala'*. In practice, the sign is a symbol to the public not to leave or enter areas that have been marked or signposted. This implementation is included in the facts because the place or area to be given a sign is a joint agreement made by the local community. The concept lies in the offerings that will be used in the *Nyangahatn* process to prepare for *Balala*'. The preparation of offerings is called a concept because this process is a stage in *Balala*' that people already understand. The community already believes that the tradition being carried out will not take place legally without offerings before the ritual takes place. The principle in *Balala'* lies in the mindset of the people. Due to the provision that one cannot leave the house which is marked by a sign in front of the alley and the *Nyangahatn* process has been carried out with the offerings used, the community believes that this ritual can get rid of all bad things. This activity is called a principle because in the process of giving offerings, the process of giving signs, and the belief in getting rid of all bad things have a relationship with one another. Skills lie in the stages carried out when *Balala'* is carried out and when preparing the offerings. Because the offerings used in the *Nyangahatn* process have special rules that must be arranged to comply with the applicable provisions. This is called skill because in practice, the arrangement of offerings should not be haphazard or placed at random. The offerings must be specially prepared and require skill in preparing them so that the *Nyangahatn* process takes place perfectly.

The indirect mathematical object of the *Balala'* ritual is the ability to think analytically, to be thorough, and to be persistent. The ability to think analytically in the *Balala'* ritual can be seen from the beliefs held by the community where people believe that by doing this ritual, they will get an abundant harvest if they are able to think critically. In this case, the ability to think analytically lies in the mindset of the people towards the belief in an abundant harvest based on the efforts they make in carrying out all the traditional *Balala'* rituals. For accuracy in the *Balala'* tradition, it can be seen from when the community prepares offerings during the *Nyangahatn* process. When preparing offerings, it must be in accordance with the rules and requires accuracy. Accuracy is very important in the preparation of offerings because the offerings should not be arranged haphazardly. The rules for the preparation and ingredients included in the offerings have been determined by the customary leader. The community must follow these rules so that the ritual runs smoothly.

**Table 1.** Mathematical Objects in the *Balala*' Ritual

| Activity | Math Objects | |
|---|---|---|
| | Direct Object | Indirect Object |
| Signs are not allowed to enter the village | Fact | Ability to think analytically, thoroughness, and perseverance |
| Stages in carrying out the ritual | Draft | |
| The mindset and belief in carrying out the ritual | Principle | |
| Preparation when Assembling offerings | Skills | |

Meanwhile, perseverance can be seen from each individual who still adheres to and practices the *Balala*' tradition with a spirit of persistence and stops all activities outside the home while *Balala*' lasts. To clarify the distribution of mathematical objects contained in the *Balala*' ritual, they are classified in the table 1.

### 3.2.2 Mathematical Objects in the *Balale'* Tradition Work System

After carrying out the *Balala'* tradition, it is then continued with the *Balale'* tradition. The fact lies in the community joining the *Lale'an* members and working the rice fields in shifts, because the people who are members of *Lale'an* and work the rice fields in turns is a symbol that the *Balale'* tradition is being carried out. This symbol is an agreement that has been agreed upon by the community. The community agrees that everyone is obliged to work the fields of the *Lale'an* participants in rotation. This rule is used in the *Balale'* tradition. The concept is based on a rotational work system. Members whose land is willing to be worked on will be worked on their rice fields first, because cultivating the land in rotation is what distinguishes the *Balale'* Tradition's rice field work from other traditions. This concept has been ingrained in society since ancient times. In the *Balale'* Tradition, the principle lies in the mindset of the people. The community believes that if something is done collectively, it will feel lighter and it will be completed more quickly. People who practice the *Balale'* Tradition have skills because the people have mastered the techniques of the *Balale'* tradition which are carried out quickly and precisely.

The indirect objects of the *Balale'* Tradition include logical reasoning, problem solving, analytical thinking, positive attitude, rigor, persistence, and discipline. Have the ability to think logically because people believe that if done together, the work will be completed quickly. Have the ability to solve problems and the ability to think analytically because the community finds ways to work the land quickly by working on it together and can use tools that can help make work easier. It has a positive nature because it can strengthen relations between people. Have accuracy and diligence because in the process of community work must be in accordance with applicable regulations. Have discipline because in carrying out the *Balale'* Tradition, one must be disciplined within the mutually agreed upon time.

**Table 2.** Mathematical Objects in the *Balale'* Ritual

| Activity | Math Objects | |
|---|---|---|
| | Direct Object | Indirect Object |
| Communities who join in *Balale'* | Fact | Ability to think logically, Ability to solve problems, and Ability to think analytically, thoroughness, and perseverance |
| The process of working the fields in turns | Draft | |
| Community Mindset | Principle | |
| Work technique of each member of the group | Skills | |

The *Balale'* tradition also contains the mathematical concept of equations with the number of *Lalean*' members who can complete the work in one day. With 7 members, the *Balale'* tradition can be completed in one day or 9 hours. Of course, this can be compared with the number of members of 10 people, the *Balale'* tradition can be done more quickly. The equation can be made as follows:

7 members of *Lale'an* = 9 hours
10 members of *Lale'an* = ,,, hours
With this equation a formula can be made:

$7\ x\ 9 = 10\ x\ Y$
$63 = 10\ Y$
$Y = 6{,}3$

From this equation, if the members in the *Balale'* tradition are added to 10 members, the *Lale'an* work can be completed in 6.3 hours or 6 hours 18 minutes. This time is shorter compared to 7 members. This is what makes the more *Lale'an* members in the *Balale'* tradition, the faster the time needed. This element is used by the people of *Nyarumkop* Village in lightening their work.

Learning resources do not only come from textbooks, but can be supported from the environment and local culture which are more meaningful for students. In learning mathematics can be taught by using culture as a learning resource. Ethnomathematics as a bridge between education and culture is able to provide knowledge with added value to be understood because it is related to habits that are able to blend in with local traditions in learning mathematics. This is because ethnomathematics offers learning based on local culture so that students can recognize and explore the culture of their nation.

Exploring mathematical objects in the *Balale'* tradition is an effective method used so that students can understand mathematics learning and understand that mathematics exists in all aspects. More than that, culture-based mathematics learning can help students to get to know and love their own culture (Dosinaeng et al., 2020).

### 3.2.3 Preparation of Culture-Based Modules

The module designed in this study follows the characteristics required as a module according to Suastika & Wahyuningtyas (Suastika & Tri Wahyuningtyas, 2018), that is: *a) Self instructional, b) Self contained, c) Stand alone, d) Adaptif, and e) User friendly.*

a) *Self Intructional.* Modules can be used as independent teaching materials so that students can have the skills to explore information and develop it independently so they don't depend on the teacher. To fulfill the self-instructional character, the module must: (1) be prepared based on the independent teaching curriculum. This module will utilize Basic Competency A.33, namely solving mathematical models and contextual problems related to SPLDV, (2) Learning materials packaged with special activity modules must be loaded. The material contained in the module is SPLDV material related to the *Balale''* Tradition labor system, (3) There are illustrations and examples to support the clarity of presentation of learning material. (4) There are practice questions used to evaluate student work. The practical questions for this module relate to the workforce system in the *Balale'* Tradition, (5) Contextual, namely the material presented is relevant to the student's atmosphere, the context of the task or activity, and the environment. Modules are presented in accordance with the environment around students, especially the use of the *Balale'* Tradition system, (6) Use language that is straightforward and communicative, (7) There is a summary of educational content, (8) There is an evaluation tool. The evaluation instrument for this module uses the Benchmarking Research Approach (PAP), (9) Students receive feedback about their assessments, and (10) There is information about improving learning materials related to the *Balale'* Tradition.

b) *Self Contained.* The modules contain all the instructional content and are bundled as a single unit. This concept aims to provide opportunities for students to examine in depth SPLDV learning materials related to the *Balale'* Tradition.

c) *Stand Alone.* Modules that are independent or independent of teaching materials and other media. This concept is intended so that students do not need additional teaching materials in studying the module. If students still need other teaching materials in studying the material in the module, then it can be said that the module developed is not included as a stand-alone teaching material.

d) *Adaptif.* Module adaptation to scientific and technological advances is very important. This concept is intended to facilitate the adaptation of modules to advances in science and technology. Incorporating content that supports learning in modules such as audio, visual or audiovisual is an example of this adaptation.

e) *User Friendly.* Modules must comply with user-friendly or user-friendly guidelines. The goal of this concept is to make each module's instructions easy to use and useful.

## 4. CONCLUSION

There are direct and indirect mathematical objects in the *Balale'* tradition. The direct mathematical object is in the form of facts that lie in the individuals who take part in *Lale'an*, concepts that lie in the process of working the rice fields in turn, and principles that lie in the mindset of the people when carrying out *Balale'* Each member of *lale'an* incorporates tradition and expertise into work practice they. The *Balale'* tradition contains mathematical objects in the form of logical reasoning, problem solving, analytical thinking, positive attitude, thoroughness, perseverance, and discipline.

In the research conducted, the researcher provides several suggestions, including that it is necessary to hold a more in-depth exploration of mathematical objects regarding traditional rituals used in carrying out the *Balale'* Tradition and in designing modules it is expected to pay attention to the characteristics required by a module, namely: *a) Self instructional, b) Self contained, c) Stand alone, d) Adaptif, and e) User friendly.*

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