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ANALYZING STUDENTS' ABILITIES AS PROSPECTIVE TEACHERS OF MATHEMATICS IN CONSTRUCTING PROOFS

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ABSTRACT

Mathematical proof demands accuracy and precision in formulating correct and logical arguments. Students need to develop their ability to produce accurate and precise proofs. This study aims to analyze the ability of prospective mathematics teachers in constructing geometry and algebraic proofs. The research subjects were 8 prospective mathematics teacher students, four male and four female. This descriptive qualitative research begins with giving tests to research subjects, and then we conduct interviews. The results showed that male students were better at compiling geometry than algebraic proofs. At the same time, female students are better at compiling algebraic proofs than in geometry. This result is due to the spatial ability of men better than women. When compiling geometry proofs, apply procedural, syntactic, and semantic proofs. When compiling algebraic proofs, only apply procedural proofs. Female students, when compiling geometry proofs, only apply procedural proofs. When compiling algebraic proofs, they apply procedural proofs and syntactic proofs.

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1. INTRODUCTION

The development of mathematics encourages humans to be more creative in applying mathematics in everyday life. This application of mathematics cannot be separated from the ability to solve problems that require an understanding of concepts. On the other hand, mathematical concepts can be obtained or developed through mathematical proof. The ability to construct logical and structured proofs is a key indicator in understanding and

mastering mathematical concepts in depth. However, in practice, many students face difficulties compiling good and correct proofs, both in geometry and algebra (Oxburgh, 2021). In mathematical epistemology, proof is considered as the main foothold for building valid mathematical knowledge. The construction of proof involves a deep understanding of mathematical concepts, consistent use of logic, and critical abstract thinking. Mathematical knowledge is considered an objective reality that exists beyond individual perception. This implies that students' ability to construct proofs depends not only on their subjective views but also on an objective understanding of mathematical concepts and the applicable rules of logic (Moore, 2016). The construction of mathematical proofs involves complex cognitive processes. Students need to organize and connect mathematical concepts, apply correct logical principles, and develop the necessary abstract thinking.

When we construct mathematical proofs it does not always go smoothly, mistakes are common (Schlesinger et al., 2018). However, these mistakes can be opportunities to improve understanding and enrich knowledge. In improving understanding and enriching knowledge, students can collaborate with others Interaction with peers, group discussions, and feedback from others can help students deepen their understanding of mathematical proofs. Constructing proofs also includes collaborative and social aspects of learning mathematical proofs. Thus, student teachers can engage their understanding of the nature of mathematical knowledge, the process of proof construction, errors and revisions, and social aspects when constructing proofs (Abbott, 2013).

The mathematical realism perspective considers mathematical entities such as numbers, patterns, and mathematical structures, to have an objective existence that is independent of the human mind (Font et al., 2013). Ontologically, research on students' ability to construct proofs will pay attention to students' relationship with mathematical entities and how they represent these entities in the proof process. From a constructivist perspective, mathematics emphasizes the role of construction and individual mental activity in the formation of mathematical knowledge. The Platonism perspective considers that mathematical entities are abstract objects that exist independently and universally (Font et al., 2013). Students interact with these mathematical subjects.

The structuralist perspective emphasizes the importance of structure and pattern relationships in mathematics. Students recognise, understand, and use mathematical structures in constructing proofs, both in geometry and algebra. Research on analysing students' ability to construct mathematical proofs will gain a deeper understanding of the nature of the mathematical entities involved, the relationships between mathematical concepts, and the role of human thinking in the proof process (Feriyanto, 2018).

Mathematical proof demands accuracy and precision in formulating correct and logical arguments. Students need to develop their ability to produce accurate and precise proofs (Cheng, 2017). Mathematical proofs must be able to be structured in a way that is clear and can be understood by others. Students' ability to construct proofs that can be communicated well is important in the context of axiology. Mathematical proof can also be considered as an art form that shows beauty and harmony in the construction of arguments and relationships between mathematical concepts. The process of mathematical proof involves critical thinking and reflection on the concepts and arguments used. Research can involve evaluating students' ability to analyse and evaluate the mathematical proofs they encounter, and to identify weaknesses or errors in those proofs.

Mathematical proof is closely related to geometry and algebra. Geometry and algebra complement each other and help in understanding mathematical concepts thoroughly (Usiskin, 2021). This interrelationship allows for the simultaneous use of geometry and algebraic approaches in solving mathematical problems, modelling real-world situations, and developing a deeper understanding of mathematical concepts. Mathematical proofs

often require perseverance and creativity in finding new approaches and innovative solutions. Students' ability to construct mathematical proofs can involve a deeper understanding of the values associated with mathematical proofs and how they can be applied in learning and assessment contexts (Kelley & Knowles, 2016).

The problem in this study is how the ability of prospective mathematics teachers in preparing geometry and algebra proofs. Some of the problems that may arise include: difficulty in identifying the right steps to construct a proof; lack of understanding of the structure of the proof and how to organise arguments logically; difficulty in understanding the mathematical concepts underlying the proof; lack of ability in connecting different mathematical concepts to construct a consistent proof; and difficulty in applying abstract thinking in constructing mathematical proofs (Stylianides et al., 2016) .

This study aims to describe the ability of prospective mathematics teachers in constructing geometry and algebraic proofs based on the problems faced by students in constructing mathematical proofs and identifying factors that affect their ability. This article can be a new insight in the context of teaching mathematics because it discusses how prospective teachers integrate the concepts of geometry and algebra in preparing proofs.

2. METHOD

Our research is qualitative descriptive research. We describe the ability of prospective mathematics teacher students in preparing geometry and algebraic proofs. The natural subjects of the research were 8 mathematics teacher candidates. Four male and four female students. We asked them to construct one geometry proof and one algebra proof. We provided two geometry problems and two algebra problems, but students were asked to do one problem each. The proof we provided are as follows.

1. Prove that the product of two consecutive integers is always divisible by 2

2. Prove that the product of three consecutive integers is always divisible by 6

Figure 1. Algebra Problem

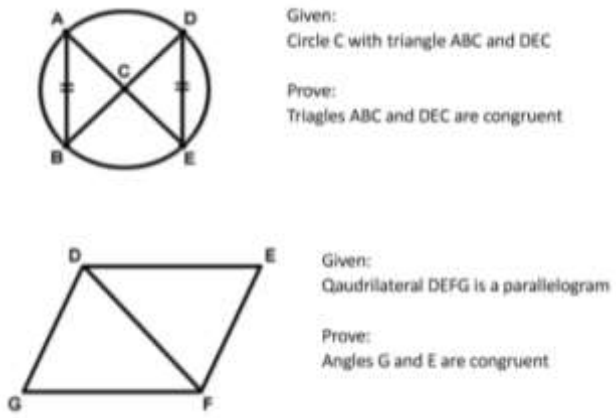


Figure 2. Geometry Problem

We interviewed the subjects using semi-structured interviews. We did it after the subject finished working on geometry and algebra problems. Next, we analyzed the results of

compiling evidence and interviews based on the process of compiling evidence. The way we analyzed the data was by reducing, presenting data, and making conclusions so that we obtained an analysis of the ability of prospective mathematics teachers in constructing the proof. Here is the process of constructing proofs that students can use (Weber et al., 2014).

Table 1. The Constructing Proofs Process

Process	Aspects
Procedural Proofs	Try to build a proof by applying the procedure
	Define a specific set of steps
Synthetic Proofs	Manipulating definitions
Semantic Proofs	Trying to understand why a question is correct by checking the representation

3. RESULTS AND DISCUSSION

3.1. Results

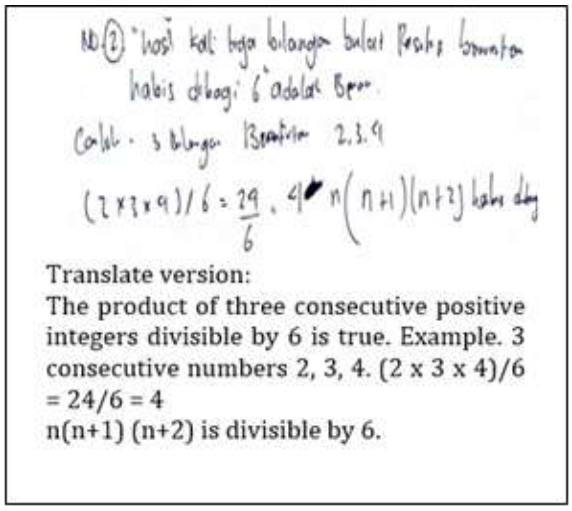
In this section, we describe the research data based on tests and interviews with 8 prospective mathematics teacher students. We gave students the task of constructing proofs related to geometry and algebra material. In the first part, we describe the students' work in constructing geometry proofs. This study was designed to investigate the students' proof ability. First, we analysed four male subjects' proofs in algebra.

Table 2. Analysis of Male Subjects in Constructing Proofs of Algebraic

Subject	Result	Analysis
AA	AA wrote an example of 3 positive numbers that when added together are divisible by 6. Suppose the numbers are 2, 3, and 4. Furthermore, he wrote "So, the statement is True".	AA attempts to construct proof by applying a procedure (applying procedural evidence)
MH	MH denote two numbers by a and a+1, and suppose a is an even number then it must be divisible by 2 because it is 2. Suppose 0, 2, 4, ... etc. are divisible by 2 or -2, -4 are also divisible by 2.	MH tries to construct proof by applying a procedure (applying procedural proof)
BD	BD wrote that two integers are divisible by 2 if the last number is divisible by 2. Suppose the integers are 3 and 2 then 3 x 2 = 6, since 2|6	BD tries to build evidence by applying a procedure (applying procedural proof)
MR	MR menuliskan contoh 3 bilangan positif yang jika dijumlahkan habis dibagi 6. Kemudian menuliskan n(n+1)(n+2) habis dibagi 6.	MR wrote down an example of 3 positive numbers that when added together are divisible by 6. Then wrote n(n+1)(n+2) is divisible by 6.

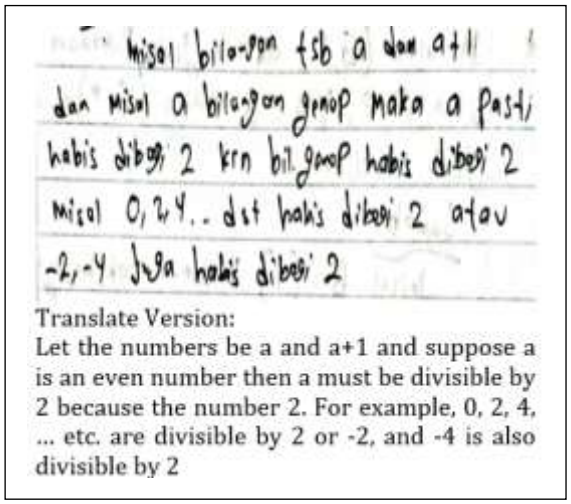
From table 2, it can be seen that all four subjects applied procedural proofs, i.e. tried to build evidence by applying procedures. They determined a specific set of steps they believed would result in a valid proof. It is possible that the procedure is meaningful to the

proof. They understand why successful application of the procedure will result in a logical argument and establish the truth of the claim to be proved. H ere are MR and MH's answers and our interviews with them.



Translate version:
The product of three consecutive positive integers divisible by 6 is true. Example. 3 consecutive numbers 2, 3, 4. (2 x 3 x 4)/6 = 24/6 = 4
n(n+1) (n+2) is divisible by 6.

Figure 3. Subject MR's Answer



Translate Version:
Let the numbers be a and a+1 and suppose a is an even number then a must be divisible by 2 because the number 2. For example, 0, 2, 4, ... etc. are divisible by 2 or -2, and -4 is also divisible by 2

Figure 4. Subject BD's Answer

From both pictures, we can see that they only applied procedural proof. But what they have done has not applied the steps of proof that have been taught. Although they realize that constructing proof requires logical thinking. This is implied in the following interview results.

P : How do you understand the concept of mathematical proof?
MR : In my opinion, the mathematical proof is work that requires convincing the correctness of a theorem.
P : How do you see the role of logic in constructing mathematical proofs?
MH : Very important, because obtaining valid evidence must involve logical thinking

We do not present the work and interviews of the other two subjects, because their work and interviews are almost the same as those of MR and BD. In the second part, we analyzed four male subjects in constructing geometry proofs.

Table 3. Analysis of Male Subjects in Constructing Proofs of Geometry

Subject	Result	Analysis
AA	AA write "Find $AB \cong DE$, hence $\overline{AC} = \overline{CD}, \overline{CB} = \overline{CE}, \angle CAB = \angle CDE, \angle CBA = \angle CED, \angle ACB = \angle DCE, \overline{AE} = \overline{DB}$, SO $\Delta ABC \cong \Delta DEC$"	AA attempts to construct evidence by applying a procedure (applying procedural proof), manipulating definitions (applying syntactic proof), and examining representations (applying semantic proof).
MH	MH wrote "Based on the properties of a parallelogram: $\angle G = \angle D = \angle E = \angle F = 90^o$, jadi $\angle G =$	MH attempted to apply procedural evidence by trying to construct evidence by applying a procedure

Subject	Result	Analysis
	$\angle E\ (same), \angle G =$ $\angle E\ (retrieved\ from), \angle G =$ $\angle G\ (kongruen)$"	despite making mistakes
BD	BD only wrote down the angles but not clearly enough	BD does not apply any proof
MR	MR write "$AB \cong DE$, hence $\overline{AC} = \overline{CD}, \overline{CB} = \overline{CE}, \angle CAB = \angle CDE,$ $\angle CBA = \angle CED, \angle ACB =$ $\angle DCE, \overline{AE} = \overline{DB}$, So $\Delta ABC \cong \Delta DEC$"	AA attempts to construct proof by applying a procedure (applying procedural proof), manipulating definitions (applying syntactic proof), and examining representations (applying semantic proof).

Based on table 3. it can be seen that subjects AA and MR applied procedural evidence, i.e. tried to build evidence by applying procedures. They determine a specific set of steps they believe will produce a valid proof. It is possible that the procedure is meaningful to the proof. They understand why successful application of the procedure will result in a logical argument and establish the truth of the claim to be proved. They also apply syntactic proofs, i.e. trying to write proofs by manipulating correctly stated definitions and other logically relevant facts. Finally, they applied semantic proofs, i.e. trying to understand why a statement is true by examining representations (e.g. diagrams) of relevant mathematical objects and then using these intuitive arguments as a basis for constructing formal proofs. The following are AA and MR's answers and the results of our interviews with them.

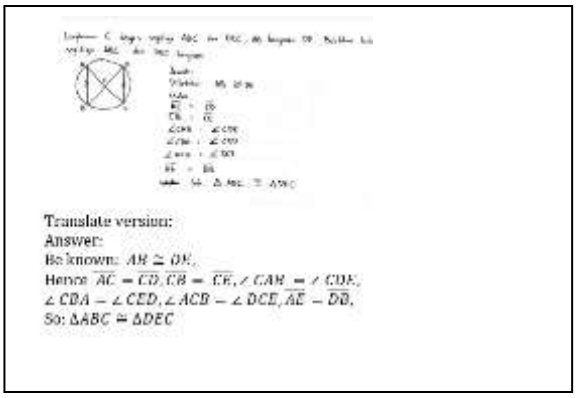


Figure 5. The answer of subject AA

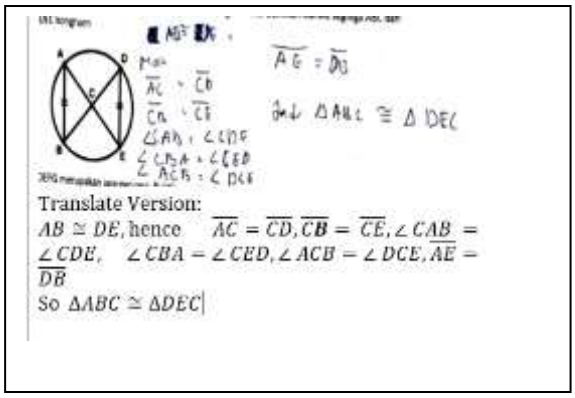


Figure **6**. The answer of subject MH

From the two pictures, we can see that they only applied procedural proof, syntactic proof, and semantic proof. Although they stated that they had experienced difficulties when compiling the Proof but, in the end, they could overcome the difficulties experienced because they already had the right technique or strategy. They have also ensured that the evidence compiled is correct and precise. They can also develop the ability to compile evidence. This is implied in the following interview results.

P : What obstacles or difficulties do you face when trying to construct mathematical proofs?

AA : I have trouble finding the right ideas or concepts to

prove my point.

P : How did you overcome these difficulties or obstacles?
MR : By remembering the theorems that have been taught
P : What techniques or strategies do you usually use in constructing mathematical proofs?
AA : Modelling and analogising with existing theorems
P : How do you ensure that the evidence you compile is correct and complete?
MR : By looking back at the proofs, I have obtained
P : How have you developed your mathematical proof building skills over time?
AA With more reading and practice compiling evidence

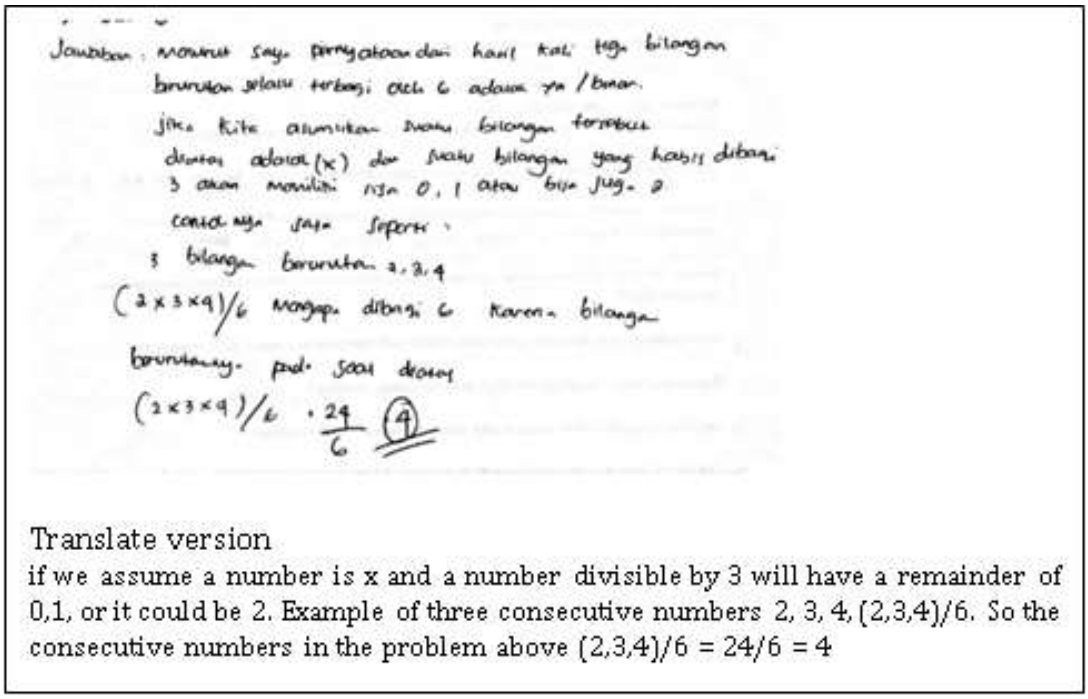
We do not present the work and interviews of the other two subjects, as the work does not fulfil the requirements of the proof. In the third part, we analysed four female subjects in constructing proofs of algebraic.

Table 4. Analysis of Female Subjects in Constructing Proofs of Algebraic

Subject	Result	Analysis
AR	AR write $(n-1)(n)(n+1) = n^3n + 3n^2 + 3n = 3n^2 + 3n + 3(n^2+1)$	AR mencoba untuk membangun bukti dengan menerapkan sebuah prosedur (menerapkan bukti prosedural) meskipun tidak sampai pada hasil akhir
IK	IK wrote "if we assume a number is x and a number divisible by 3 will have a remainder of 0,1, or it could be 2. Example of three consecutive numbers 2, 3, 4, (2,3,4)/6". So the consecutive numbers in the problem above (2,3,4)/6 = 24/6 = 4	IK tries to build evidence by applying a procedure (applying procedural evidence)
CN	CN wrote that if the integer is even, then it is always divisible by 2, if the integer is odd, suppose a = odd integer, 1 = odd integer then a+1 = even number. Even numbers are always divisible by 2	BD tries to construct evidence by applying a procedure (applying procedural evidence)
NS	NS Write down: Two consecutive numbers: n, n+1, 2|n(n+1), 2| $n^2 + n$, forn = 1, $n^2 + n$ so 2|2 so the property 2| $n^2 + n$ is true for n = 1. Suppose the property 2| $n^2 + n$ is true n = k, yaitu 2| $k^2 + k$. it will be proved that the property 2| $n^2 + n$ is true for n = k+1, i.e 2| $(k+1)^2 +$	NS tried to construct a proof by applying a procedure (applying procedural proof), manipulating definitions (applying syntactic proof), and examining representations (applying semantic proof).

Subject	Result	Analysis
	$(k+1)$. Note that $(k+1)^2 + (k+1) = (k^2 + 2k + 1 + k + 1) = k^2 + 2k + 2 = k^2 + k + 2(k+1)$. So the property $2\mid n^2 + n$ is true for n = k+1. By mathematical induction, the property $2\mid n^2 + n$ is true for all natural numbers n.	

Based on table 4. it can be seen that three subjects (AR, IK, CN) applied procedural evidence, i.e. tried to build evidence by applying procedures. They determine a specific set of steps they believe will produce a valid proof. It is possible that the procedure is meaningful to the proof. They understand why successful application of the procedure will produce a logical argument and establish the truth of the claim to be proved. Whereas subject NS applied procedural evidence, which is trying to build evidence by applying procedures. He determines a specific set of steps they believe will produce valid evidence. It is possible that the procedure is meaningful to the proof. He understands why successful application of the procedure will produce a logical argument and establish the truth of the claim to be proved. He also applied syntactic proof, which is trying to write a proof by manipulating correctly stated definitions and other logically relevant facts. Finally, NS applied semantic proof, which is trying to understand why a statement is true by examining representations (e.g. diagrams) of relevant mathematical objects and then using these intuitive arguments as the basis for constructing a formal proof. The following are IK and NS' answers and the results of our interviews with them.



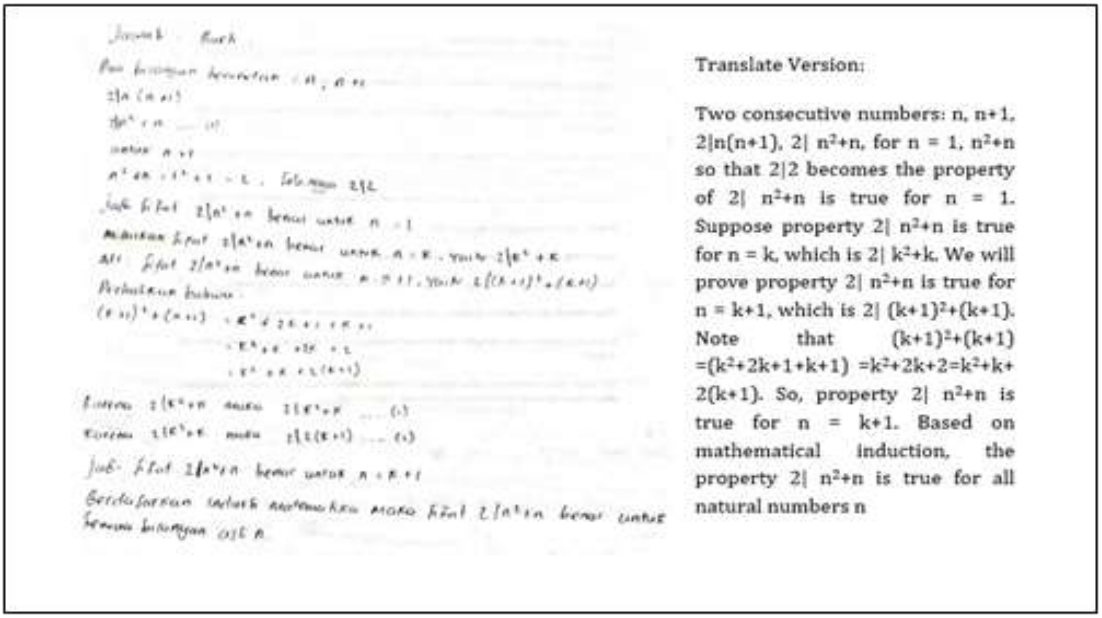
Translate version

if we assume a number is x and a number divisible by 3 will have a remainder of 0,1, or it could be 2. Example of three consecutive numbers 2, 3, 4, (2,3,4)/6. So the consecutive numbers in the problem above (2,3,4)/6 = 24/6 = 4

Figure 7. the answer of subject IK

Based on Figure 7 we can see that IK only applied procedural proof. But what he did has not applied the proof steps that have been taught. Even though he realised that compiling proofs requires logical thinking. This is implied in the following interview results.

P : *How do you understand the concept of mathematical proof?*
IK : *Find the truth of mathematical statements*
P : *How do you see the role of logic in constructing mathematical proofs?*
IK : *I think it is important to involve logical thinking when compiling proofs.*



Translate Version:

Two consecutive numbers: n, n+1, 2|n(n+1), 2| n^2+n, for n = 1, n^2+n so that 2|2 becomes the property of 2| n^2+n is true for n = 1. Suppose property 2| n^2+n is true for n = k, which is 2| k^2+k. We will prove property 2| n^2+n is true for n = k+1, which is 2| $(k+1)^2$+(k+1). Note that $(k+1)^2$+(k+1) $=(k^2+2k+1+k+1) = k^2+2k+2=k^2+k+2(k+1)$. So, property 2| n^2+n is true for n = k+1. Based on mathematical induction, the property 2| n^2+n is true for all natural numbers n

Figure 8. The Answer of Subject NS

Based on figure 8 we can see that NS tried to construct the proof by applying a procedure (applying procedural proof), manipulating the definition (applying syntactic proof), and checking the representation (applying semantic proof). NS subject understood the concept of proof and realised the role of logic in proof. This is implied in the following interview results

P : *How do you understand the concept of mathematical proof?*
NS : *The concept of mathematical proof is a concept used for the truth of a theorem with the help of logic.*
P : *How do you see the role of logic in constructing mathematical proofs?*
NS : *The role of logic in proof: making reasonable arguments, making logical connections between concepts and facts, conjecturing and testing based on reason, solving mathematical problems rationally.*

Based on an interview, NS understood the importance of logical thinking in constructing proofs, namely making reasonable arguments, making logical connections between concepts and facts, conjecturing and testing based on reason, and solving mathematical problems rationally.

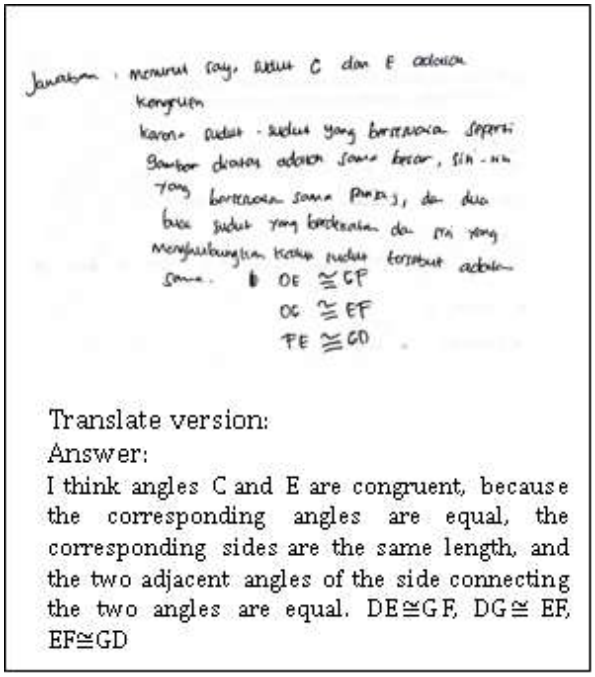
In the fourth section, we present our analysis of four female subjects in constructing

geometry proofs.

Table 5. Analysis of Female Subjects in Constructing Geometry Proofs

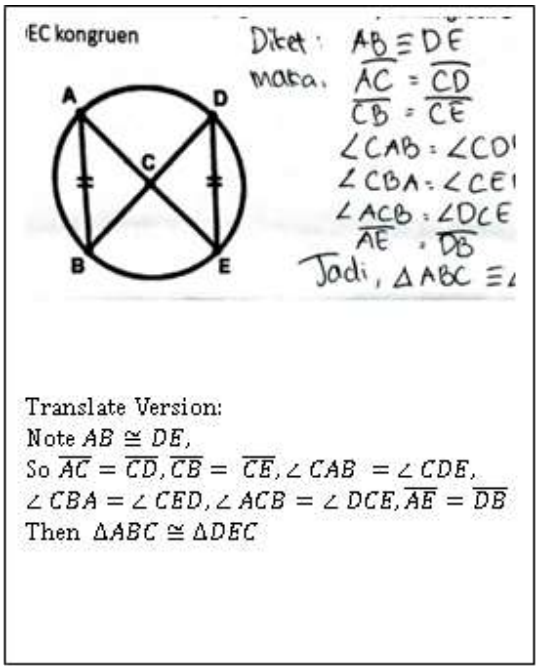
Subject	Result	Analysis
AR	AR did not write anything down	AR does not apply any proof
IK	MH wrote "I think angles C and E are congruent, because the corresponding angles are equal in magnitude, the corresponding sides are equal in length, and the two adjacent angles of the side connecting the two angles are equal.. $DE \cong GF$, $DG \cong EF$, $EF \cong GD$	IK attempted to apply procedural evidence by trying to construct evidence by applying a procedure despite making mistakes
CN	CN wrote "Known: $AB \cong DE$, $Hence\ \overline{AC} = \overline{CD}, \overline{CB} = \overline{CE}, \angle CAB = \angle CDE$, $\angle CBA = \angle CED, \angle ACB = \angle DCE, \overline{AE} = \overline{DB}$, So: $\Delta ABC \cong \Delta DEC$	CN attempts to construct evidence by applying a procedure (applying procedural evidence), manipulating definitions (applying syntactic evidence), and examining representations (applying semantic evidence).
NS	NS write "$GR \cong DE$, GD $\cong RE$, DF is the diagonal of the plane, so $DF \cong FD$. Thus, the corresponding side of ΔGFD and ΔEDF same length. Jadi ΔGFD and ΔEDF is congruent"	NS tries to construct proof by applying a procedure (applying procedural proof), manipulating definitions (applying syntactic proof)

Based on table 5. it can be seen that subject IK tried to apply procedural evidence by trying to build evidence by applying a procedure despite making mistakes. CN tried to build evidence by applying a procedure (applying procedural evidence), manipulating definitions (applying syntactic evidence), and checking representations (applying semantic evidence). NS tried to construct the proof by applying a procedure (applying procedural proof), manipulating the definition (applying syntactic proof) despite adding brau dots which were not needed. Here are IK and CN's answers and the results of our interviews with them.



Translate version:
Answer:
I think angles C and E are congruent, because the corresponding angles are equal, the corresponding sides are the same length, and the two adjacent angles of the side connecting the two angles are equal. DE≅GF, DG≅ EF, EF≅GD

Figure 9. The Answer of Subject IK



Translate Version:
Note $AB \cong DE$,
So $\overline{AC} = \overline{CD}, \overline{CB} = \overline{CE}, \angle CAB = \angle CDE, \angle CBA = \angle CED, \angle ACB = \angle DCE, \overline{AE} = \overline{DB}$
Then $\Delta ABC \cong \Delta DEC$

Figure 10. The Answer of Subject CN

From the two pictures, we can see that they only applied procedural proof, syntactic proof, and semantic proof. Although they stated that they had difficulties when compiling the evidence, they were able to overcome the difficulties experienced because they already had the right technique or strategy. They have also ensured that the evidence compiled is correct and precise. They can also develop the ability to compile evidence. This is implied in the following interview.

P : What obstacles or difficulties do you face when trying to construct mathematical proofs?
IK : Sometimes find it difficult to think logically about new or unprecedented proofs
P : How did you overcome these difficulties or obstacles?
NC : Seek information from various sources (learning) and learn more specifically about how to compile evidence.
P : What techniques or strategies do you usually use in constructing mathematical proofs?
IK : Try to remember the theorems learnt in the past
P : How do you ensure that the evidence you compile is correct and complete?
NC : By proving not just once and looking back at the proof constructions I have done
P : How have you developed your mathematical proof building skills over time?
IK Try more exercises

From the interview results, it was seen that they had difficulty thinking logically, to overcome it by learning from various sources. They recalled the theorems they had learnt to construct the proof. They make sure that the proof construction is correct by rechecking

the results obtained. They tried many exercises to develop the ability to construct proofs.

3.2. Discussion

Based on the analysis we have done, male prospective mathematics teacher students in preparing algebraic proofs only apply procedural proofs, namely trying to build proofs by applying procedures. They determine a specific set of steps that they believe will produce a valid proof. Such proof is called pure formal deduction (Bosque et al., 2017). Whereas when constructing geometry proofs, in addition to applying procedural proofs, they apply syntactic proofs, which are trying to write proofs by manipulating correctly stated definitions and other logically relevant facts. This kind of thing is often referred to as proofs based on main ideas (Raman, 2003). In addition, they also apply semantic proofs, i.e. trying to understand why a statement is true by examining representations (e.g., diagrams) of relevant mathematical objects and then using these intuitive arguments as a basis for constructing formal proofs. Composing such proofs is often called proofs that follow intuitive thinking (Weber et al., 2014).

Female prospective mathematics teacher students in preparing algebraic proofs mostly apply procedural proofs. It is possible that the procedure is meaningful to the proof. They understand why successful application of the procedure will produce a logical argument and establish the truth of the claim to be proved. There are students who apply syntactic proofs, which is trying to write proofs by manipulating correctly stated definitions and other logically relevant facts. In addition, she also applied semantic proof, which is trying to understand why a statement is true by examining representations of relevant mathematical objects. This can happen due to several factors, such as individual preferences in learning mathematics, previous learning experiences, interest and aptitude in learning mathematics. Someone who has a strong interest in mathematical concepts will be more likely to use syntax or semantics in understanding the basics of mathematics (Mainali, 2021).

Thus, we see that male pre-service teachers are better at constructing geometry proofs than female pre-service teachers. Conversely, female students are better at compiling algebraic proofs than male students. This is in accordance with the statement of (Maccoby & Jacklin, 2016), men and women have different abilities, among others: Men are superior in visual spatial abilities than women;. men dominantly use their spatial abilities while women use less spatial abilities. Spatial ability here is closely related to geometry ability according to the results of research Capraro (2001) 83% of spatial ability affects geometry ability, the remaining 17% is influenced by other factors not studied. They had difficulty in identifying the appropriate steps to construct a proof; lack of understanding of the structure of the proof and how to organise the argument logically; difficulty in understanding the mathematical concepts underlying the proof; lack of ability in connecting different mathematical concepts to construct a consistent proof; and difficulty applying abstract thinking in constructing mathematical proofs. This could be due to a lack of understanding of basic mathematical concepts, lack of practice and experience, or inappropriate teaching methods applied when learning mathematical proofs (Chebet, 2015).

4. CONCLUSION

The ability of prospective mathematics teachers to prepare proofs in this study is explained in three ways: applying procedural, synthetic, and semantic proofs. There are differences in the ability to compile evidence between male and female students. Male students are better at compiling geometry evidence than female students. Conversely,

female students have better abilities in terms of compiling algebraic proofs. Of course, this is beyond the causal factors, such as health, readiness to work on problems, and other factors. Conversely, female students have better abilities in terms of compiling algebraic proofs. Of course, this is beyond the causal factors, such as health, readiness to work on problems, and other factors.

Therefore, we suggest future researchers research compiling proofs related to influencing factors in more detail. We also hope prospective mathematics teacher students practice a lot in compiling geometric and algebraic proofs because it can strengthen mathematical concepts.

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ANALYSIS OF CRITICAL THINKING OF PROSPECTIVE MATHEMATICS TEACHERS IN SOLVING ASSESSMENT PROBLEMS

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ABSTRACT

Professional teacher candidates must have several competencies, including pedagogical competence. This competency is essential to understand the characteristics of students in various aspects. Simple qualitative descriptive research that describes the critical thinking skills of prospective mathematics teachers based on the percentage of achievement of critical thinking skills test results. We researched 6th-semester students of the Mathematics Education Study Program consisting of 35 students. The research instrument used critical thinking skills test questions consisting of 5 questions prepared based on indicators of critical thinking skills: identifying and interpreting, analyzing, evaluating, connecting, and solving problems. Data analysis used a percentage system. The results showed that the critical thinking skills of prospective mathematics teachers had a total average of 70% in the high category. This result is supported by the percentage of critical thinking skills in each indicator: interpreting and identifying indicators by 85%, analyzing indicators by 70%, connecting indicators by 82.14%, problem-solving indicators by 20%, and evaluating indicators by 92.86%. The results of the percentage classified by gender show that the ability of female prospective mathematics teachers to think critically on each indicator is better than that of male prospective mathematics teachers.

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1. INTRODUCTION

The role of a teacher is one of the components that learning can achieve the goals of national education. Therefore, teachers must have several competencies that must be mastered as stated in the Law on Teachers and Lecturers. These competencies include pedagogical, personality, social, and professional competence. Prospective teachers, including prospective mathematics teacher students, must also possess these competencies. According to Shulman, there is seven basic knowledge in teaching, namely mathematical content knowledge (MCK), pedagogical knowledge, pedagogical content knowledge (PCK), curriculum knowledge, student knowledge, educational context knowledge, and knowledge of educational goals (Shing et al., 2015). Mathematics content knowledge includes a teacher's ability to explain why something is considered true, the relationship between one statement and another, and knowing why something is so can show valid evidence supporting a statement's truth. Low mathematics content knowledge can hinder a teacher's ability to analyze students' mathematical abilities (Gess, 2013). This condition shows that teachers' mathematics content knowledge affects and becomes one of the determinants of success in learning. Therefore, prospective teachers must have good analytical skills and critical thinking.

Critical thinking is effective in helping student teachers understand mathematical concepts. Someone who thinks critically will organize concepts in detail, check information, and evaluate in order to obtain relevant knowledge (Chukwuyenum, 2013). Critical thinking is an essential ability that must be possessed by students both in problem solving and in making decisions so that they will get good results. Students need to practice critical thinking because it will make it easier for students to solve problems. In accordance with the explanation that a person's thinking ability cannot be developed without explicit effort and deliberately trained (Heard et al., n.d.). Critical thinking includes thinking that tests, questions, connects, evaluates all aspects that exist in the situation or problem that arises. This is in line with Facione's opinion (Pratiwi, 2015), which states that critical thinking skills can be measured through the ability to interpret, analyze, evaluate, identify, explain, and self-regulation (Facione, 2020). So in this study, the indicators used to measure critical thinking skills are as follows: 1) Interpretation and identification; 2) Analysis; 3) Evaluation; 4) Connecting; 5) Problem Solving. Critical thinking is considered effective in helping prospective teacher students in mastering mathematical content knowledge, critical thinking will also affect the quality of learning assessment instruments at school. the preparation of the quality of learning assessment instruments at school carried out by student teachers prospective teachers. A good school learning assessment instrument can measure the success of learning objectives appropriately (Pratiwi, 2015). In addition, one of the problems in the mathematics education study program of STKIP PGRI Sidoarjo is the heterogeneous student input in mathematics ability and major background at the secondary school level. Not all students who choose the mathematics education study program come from MIPA majors, even some of them come from vocational schools. Likewise, the results of research conducted by Fikriyati show that the disposition and critical thinking skills of prospective science teachers are still relatively low and underdeveloped (Fikriyati et al., 2022). To find out the critical thinking skills of prospective mathematics teachers, therefore, a study is needed on the analysis of critical thinking of prospective mathematics teachers as a form of effort to prepare students as prospective teachers and know their level of critical thinking.

2. METHOD

The subjects of this study were sixth semester students of Mathematics Education Study Program of STKIP PGRI Sidoarjo. The selection of this subject is with the

consideration that students have taken almost all the compulsory courses in the Mathematics Education Study Program so that the provisions as prospective mathematics teachers have been fulfilled. The instrument used in this research is a critical thinking test question in the form of 5 essay questions. The questions in the critical thinking test questions are compiled based on critical thinking indicators, then the questions are validated by experts. Data collection begins with giving critical thinking test questions to students, and continued data analysis using quantitative descriptive analysis techniques obtained in the form of percentages. The data that has been collected is then scored (each question has a score of 0 - 4). After the scoring is done, it is then analyzed in the form of a percentage with the aim of facilitating the determination of student dominance in critical thinking skills using the following formula:

$$\frac{sum\ of\ the\ scores\ of\ each\ indicator}{total\ number\ of\ respondents\ \times maximum\ score} \times 100\%$$

The calculation data in the form of percentages that have been obtained through descriptive analysis is carried out to provide a general description of the critical thinking skills of prospective mathematics teachers. Furthermore, the percentage is used to classify the level of critical thinking ability according to table 1 below (Arikunto, 2008):

Table 1. Critical Thinking Ability Criteria

Percentage Level (%)	Qualification
81 – 100	Very High
61 – 80	High
41 – 60	Medium
21 – 40	Low
0 – 20	Very Low

3. RESULTS AND DISCUSSION

3.1. Results

Based on the research data obtained from the results of tests conducted on 35 students, the following are presented the results of the percentage score as follows:

Table 2. Percentage Results of Critical Thinking Ability

Critical Thinking Indicator	**Percentage (%)**
Identify & Interpret	85 (very high)
Analyzing	70 (high)
Connecting	82.14 (very high)
Problem Solving	20 (very low)
Evaluating	92.86 (very high)
Overall	70 (high)

Table 3. Percentage students of critical thinking ability based on Gender

Critical Thinking Indicator	**Percentage (%)**	
	Male	**Female**
Identify & Interpret	80 (high)	90 (very high)
Analyzing	70 (high)	70 (high)
Connecting	79,27 (high)	85 (very high)

Critical Thinking Indicator	Percentage (%)	
	Male	Female
Problem Solving	10 (very low)	30.2 (low)
Evaluating	90 (very high)	95,6 (very high)
Overall	65 (high)	75 (high)

Based on table 2, it can be seen that the highest percentage of indicators of critical thinking ability of prospective mathematics teachers is evaluating. This shows that the evaluation indicator is the best critical thinking ability indicator possessed by prospective mathematics teachers at STKIP PGRI Sidoarjo. While the indicator with the lowest percentage is the indicator of solving problems. However, when viewed based on table 2, the indicators of identifying, connecting, and analyzing are in the high and very high categories. Overall, the percentage of achievement of critical thinking indicators reached 70% with a high category, which means that overall students' critical thinking skills are good even though they still need an improvement process on problem solving indicators because the percentage of achievement was 20% with a low category.

The precentage of critical thinking skills based on gender as seen in table 3 shows that, male students get the highest percentage on evaluation with a percentage of 90% (very high category). Female students get the highest percentage on the evaluation indicator reaching 95.6% with very high category. From the percentage value of each critical thinking indicator, it shows that female students' scores are higher than male students' scores. Its mean that female students' critical thinking skills are better than male students' critical thinking skills.

3.2. Discussion

Based on the results of the analysis contained in Table 2, it is known that the critical thinking skills of prospective mathematics teachers at STKIP PGRI Sidoarjo are classified in the high category. This can be seen from the results of the answers of students who answered correctly.

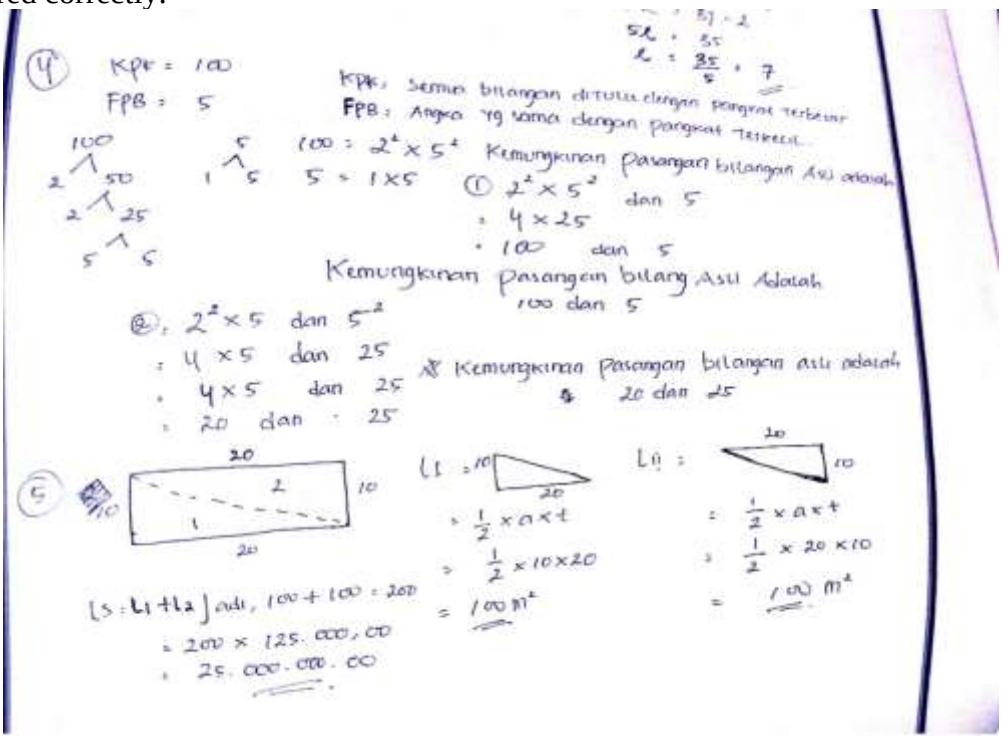

Figure 1. Work student results (a)

From the picture, it can be seen that students wrote their answers in a very detailed, systematic, and clear manner. In Addition, the high critical thinking skills of prospective teachers are due to the fact that the lecture process always involves activities that lead to critical thinking and practice in the learning process. Although there is still a need to improve critical thinking skills on the aspect of solving problems as seen in the results of the following student answer.

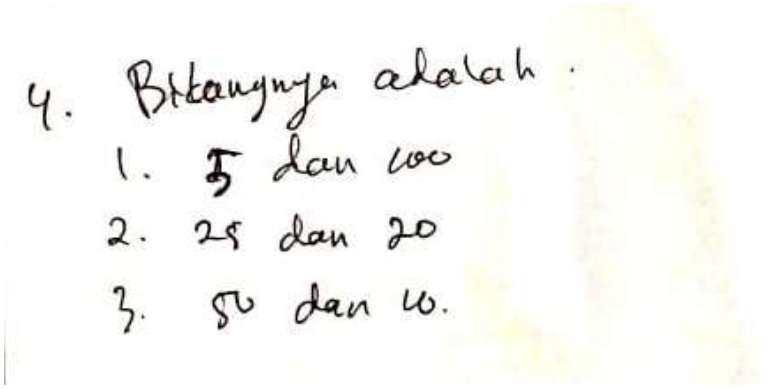

Figure 2. Work student results (b)

From the figure 2, students only write the final result of the answer and do not write the steps of the answer completely and coherently. This is consistent with the research which state that students' lack of basic knowledge results in them not being able to solve the problems posed properly and wrote the answer completely (Sumargiyani et al., 2021)(Noprianda et al., 2019). This can happen because their previous educational background is diverse. They did not only come from high school, but also from vocational schools with non-engineering specializations, for example from tailoring specializations.

The low level of critical thinking skills in the aspect of problem solving is caused by classroom learning carried out by lecturers who also do not train students in solving problems. This can be seen from the learning activities that are carried out are monotonous, do not explore students' critical thinking skills, limited learning resources, and lack of exploring phenomena around the environment and supported by the results of research which states that problem solving skills can be improved through routine practice and a supportive learning atmosphere (Çarkit & Kurnaz, 2022). Critical thinking skills in terms of solving problems can be raised through strengthening concepts and appropriate learning activities. One of them is by using certain active learning models that contain problem solving exercises that can foster critical thinking.

Critical thinking is an activity that is influenced by the learning experience obtained by students (Fahim & Eslamdoost, 2014). If during the learning process students are often given exercises or activities to carry out critical thinking activities, then students will have good development of critical thinking skills in every aspect, including the aspect of problem solving. Critical thinking is a well-organized mental process that plays a role in the decision-making process of solving problems by analyzing and interpreting data in scientific investigation activities(Hafidz et al., 2022). Lecturers need to choose a learning model that can involve students in practicing problem-solving skills.

Critical thinking is reasonable and reflective thinking that is focused on making decisions about what to do or what to believe (Yanti et al., 2019). The statement of reasonable thinking implies thinking based on facts to produce the best decision and reflective thinking means looking consciously and firmly for the best possible solution. In

addition, critical thinking skills are skills that cannot be inherited and are not directly owned by students, so training is needed so that these skills can be owned by students, especially prospective mathematics teachers (Setiawati & Corebima, 2017). For prospective teacher students, critical thinking skills are a must-have skill considering that these students are prepared to educate students in schools. In order for students to be trained in a critical attitude, of course, the prospective teacher must first have the attitude, ability and critical thinking skills in each aspect of critical thinking in line with the results of research (DeWaelsche, 2015) which states that the ability to think critically is obtained because it is trained not inherited. Critical thinking skills play a role in processing information, solving problems, and expressing opinions so that each individual can understand the information obtained.

Based on the percentage obtained by male and female students, it can be seen that there is a difference between the percentage criteria on each critical thinking indicator. The highest percentage of female students is on the evaluation indicator and the highest percentage of male students is also on the evaluation indicator. However, the percentage value of female students is higher than male students. Overall, each percentage of the very high category is dominated by female students, while male students dominate the percentage in the high criteria. This shows that female students are overall better than male students. In line with the results of the study which states that the critical thinking skills of female students are better than those of male students (Zetriuslita, 2016).

4. CONCLUSION

The results of the study show that the critical thinking ability of prospective mathematics teachers has an overall average of 70% with a high category, which is supported by the percentage results on each indicator, namely interpreting and identifying indicators of 85%, analyzing indicators of 70%, connecting indicators of 82.14%, problem-solving indicators of 20%, and evaluating indicators of 92.86%. The percentage of each indicator shows that the critical thinking skills of female students are better than those of male students. Problem-solving indicators are low due to a lack of practice and habituation in classroom learning. Critical thinking abilities and skills are acquired due to routine habituation, not genetic inheritance. The results of this study are expected to be used by lecturers or researchers to design and develop learning activities that can facilitate students to practice critical thinking skills so that students can get used to using these skills in everyday life. Further research can be done on this case, one of which is research on developing learning tools based on problem-solving and critical thinking.

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The Effect of Ms. Teams on Math Learning Motivation and Its Implications for HOTS Skills

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ABSTRACT

The ability to think in a higher order is one of the essential abilities because every concept in mathematics is interconnected. This study aims to analyze the improvement of students' higher-order thinking skills and motivation to learn mathematics. The type of research is a combination (mixed methods) with a sequential explanatory design. The sampling technique uses cluster random sampling technique. The sample of this study was class XI IPS 4 (experiment) and XI IPS 3 (control) SMAN 3 Cirebon Instrument. This study used tests, questionnaires of motivation to learn mathematics, observation sheets of learning implementation, and data analysis techniques. The results of this study were (1) the acquisition of tests using the experimental and control class N-Gain test was 0.67 and 0.43, (2) student learning motivation in the experimental and control classes was in a suitable category, (3) the results of the student mathematics learning motivation questionnaire obtained an average initial percentage of 67.470% to 76.405% and, (4) for the percentage of observation results of the average learning implementation of 89%. This study concludes that student learning motivation in the Microsoft Teams-assisted blended learning model can positively improve students' higher-order thinking skills.

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1. INTRODUCTION

Education is the process of learning knowledge, skills, and habits of a group of humans that are passed from one generation to the next through teaching, training, and research. In line with Izzati (2017), education may be essential for every human being because, with an education, every human being will find it easier to solve the problems he is

facing. Education plays an essential role in the sustainability of human life because humans born on earth are not knowledgeable. Therefore, every human has needed education from the past until now, even in the future, to create changes in a more advanced direction and for the welfare of life. Therefore, education is expected to form quality humans with high intellect, good personalities, intelligence, noble morals and life skills (Zelhendri, 2017). In addition, education has another role: to provide everyone with helpful knowledge. The role is performed by an educator or teacher (Martina, 2017).

The increasing progress of science and technology (IPTEK) is increasingly experiencing rapid progress where the creation of various kinds of technology in various fields that aim to improve the quality of human resources (HR). This has led to the formation of a transformation in various fields, especially in the field of learning where the world of learning requires changes, especially in schools and large academies to better prepare students to improve some new skills in participating in the progress of a rapidly growing world. This advancement in science and technology (IPTEK) is used to prosper mankind. Therefore, a teacher is required to be able to creatively find and collect teaching materials needed in the learning process. However, sometimes teachers have not been able to make teaching materials or learning media that are suitable to be applied to students, there are even teachers who are reluctant to use media in teaching (Jalmur, 2017).

According to Sayyidatunnasyaa et al., (2022) there are 4 categories of skills, including higher-order thinking skills, collaborative thinking skills, and creative thinking abilities. Every mathematical idea is connected to each other, thinking skills are essential. The problems presented rationally and coherently, start from the complexity of the most basic ideas, since learning involves more than just performing quantitative calculations, it requires the application of reasoning, which is why it is so related to mathematics and thinking. There are two categories of thinking skills: low-order thinking capabilities (LOTS) and higher-order thinking capabilities (HOTS), both of which are used to refer to thinking styles (Arifin, 2017).

According Andayani & Lathifah (2019) Higher order thinking ability is the capacity for more complicated thought processes that include exposing existing information, critiquing it, and coming up with solutions to problems. In response to the same, Annuuru et al. (2017) Emphasizing that combining facts and ideas during the stages of analysis, evaluation, and creation in the form of delivering an assessment of the facts learned or being able to create something from something learned is what it means to think at a higher level. Accompanying a similar thing, Budiarta et al., (2018) said that HOTS can be understood as the capacity for complex thought processes, including the analysis of sources and the generation of solutions to problems. According to some of the viewpoints mentioned above, thinking at a higher level is a more complicated and profound cognitive skill than thinking at a lower level. This is outlined in Bloom's taxonomy.

The level of thinking capacity of a person can be classified according to Bloom's taxonomy in a hierarchical framework, from low to high. Lorin Anderson Krathwohl revised Bloom's taxonomy of skills, which is separated into two groups, in 1994 to reflect the times. The most basic thinking abilities, such as remembering, understanding, and applying, are considered low-level skills. The second category is high-level cognitive abilities, such as the capacity for analysis, evaluation, and creation; This updated Bloom taxonomy is known as Bloom's Revised Taxonomy (Anderson et al., 2001)

Previous studies of students' thinking skills, including research findings by Purbaningrum (2017), which means that students' capacity for higher-order thinking is still moderate. In addition, according to research Angraini & Sriyati (2019) Class X students in Solok city are classified as having "less" high-level thinking skills. In Solok City, the average percentage of students who show higher-order thinking skills is only 32.08%. The

percentage score for school A's accreditation is 39.41%, while the percentage score for school B's accreditation is 26.01%. Despite the fact that research by Kurniati et al. (2016) The findings of a study involving 30 students from various junior high schools in Jember Regency revealed that 18 of them showed a high level of thinking skills with a moderate level by doing good analysis, evaluation, and creation when solving various problems. In addition, 12 students were assessed as having high-level thinking skills with a low level as they struggled to apply their analytical, judgmental, creativity, logic, and reasoning skills to all situations. There must be a solution based on the current problem. Researchers have found that motivating students to learn is the best way to problem-solve higher-order thinking skills.

Learning motivation is an attempt to create a state that will make us desire to do something, and if we don't like it, it will try to make us like it (Emda, 2017). Learning motivation plays an important role, especially in learning activities. This is because when students are motivated, their excitement grows naturally, but when they lack drive, learning from them suffers. As a result, every student needs to be given the necessary tools to be motivated to learn. However, through the right learning model, it can help every student become more motivated. Blended learning is one instructional model that teachers can utilize. Blended learning combines traditional classroom instruction with technology-based instruction (Widiara, 2020). The terms mixed learning, melted learning and hybrid learning are some alternative terms that are often used to refer to the concept of unified, blended or mixed learning that refers to the same thing. But blended learning is a word often used today (Ramadhani, 2020). The blended learning model can also instill a strong desire in children to learn maths, which will help them engage in the learning process and develop the kind of problem solvers who can think critically about a subject or problem before moving on to other related issues. The result is that knowledge acquisition will usually take longer than students who have a strong motivation to learn mathematics. On the other hand, students who lack the drive to learn maths will only have teachers as their only source of learning. Media that can facilitate effective learning is also needed in addition to learning models to increase high-level cognitive abilities and student motivation. Microsoft Teams is a learning tool that can be used.

One of the technology products created specifically for the education sector is Microsoft Teams. According to Situmorang (2020) Microsoft Teams is a digital hub that brings conversations, tasks, and apps together in one location. It has a number of features, including Chat, Calls (Video Conferencing), files, Assignments or assignments feature, Classroom feature, Post feature, and Class Notebook feature, which give teachers the opportunity to develop engaging lessons for students.

Based on the above problems, researchers are interested in taking the title "Analysis of Higher Order Thinking Skills (HOTS) and Student Mathematics Learning Motivation through Blended Learning".

2. METHOD

2.1. Research Design

This study used a combination method (mixed methods) with sequential explanatory design conducted at SMAN 3 Cirebon. The research flow can be seen in Figure 1.

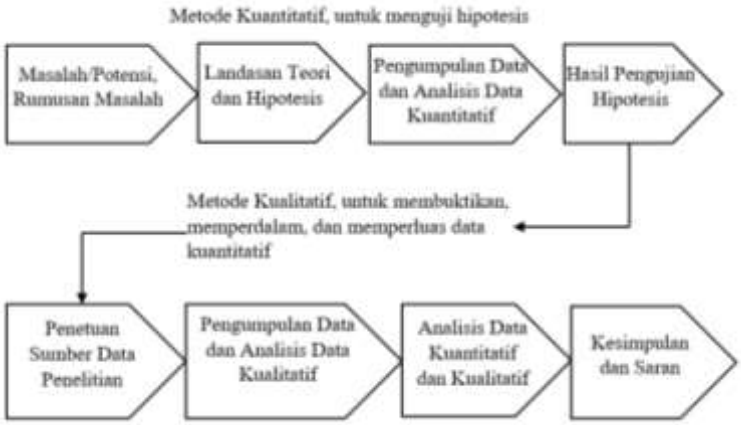

Figure 1. Research Steps in Sequential Explanatory Design

The population for this study consisted of all grades XI students at SMAN 3 Cirebon. The sample of this study consisted of 72 class XI social studies students who had taken the Derivative of Algebraic Functions course. Cluster random sampling technique is used for sampling. Class XI IPS 3 (Control class) and class XI IPS 4 (Experimental class) are classes used for research. In this study, the independent variable was students' math learning motivation when using the Microsoft Teams-assisted blended learning paradigm. While the ability to think higher order is the dependent variable in this study. The research instruments used include learning motivation questionnaires, high-level thinking ability test questions, and observation sheets for learning implementation.

This questionnaire is used to measure the motivation of each student. The questionnaire consists of 25 questions. For the need to compile several statements, a questionnaire grid was made as follows:

Table 1. Questionnaire Indicators

Indicator	Statement Number	Statement		Number of Statements
		(+)	(-)	
There is a desire and desire to succeed	1,2,3,4,5,6	4	2	6
There is a push	7,8,9,10,11	2	3	5
The existence of hopes and aspirations for the future	12,13,14,15,16	2	3	5
There is an appreciation in learning	17,18,19,20	1	3	4
Interesting activities	21,22	1	1	2
The existence of a conducive situation	23,24,25	1	2	3

The next instrument is a test, a test used to determine the improvement of students' higher-order thinking skills. This test is carried out 2 times, namely before learning (pretest) and after learning (posttest). This test consists of 15 questions where the full details are in the following table:

Table 2. Test Question Details

	Higher Order Thinking Ability Indicators	Cognitive Realm	Question Number	Number of Questions
3.8 Describes the properties of derivatives of algebraic functions and determines derivatives of algebraic functions using definitions and properties of derivatives of functions. 4.8 Resolves problems related to derivatives of algebraic functions.	Analytical Skills	C4	1,6, 11	3
	Ability to Distinguish	C4	4,8,12	3
	Organizational Ability	C4	2, 13	2
	Connectability	C4	3,7,9	3
	Ability to Evaluate	C5	5,14	2
	Ability to Create	C6	10,15	2

Based on the quality category of learning devices, namely instruments to measure the validity of learning devices, instruments to measure the practicality of learning devices and instruments to measure the effectiveness of learning devices.

1. Test the validity of learning devices

   The validity test of learning devices is obtained from the results of validation of learning devices by a team of experts / practitioners. The learning device validity test is calculated using the following formula (Retnawati, 2016):

   $$\text{Coefficient of Validity} = D(A+B+C+D)$$

   Information:

   A = Cells that show disagreement between the two raters
   B dan C = Cells that show differences in views between raters
   D = Cells that show valid agreement between the two raters

   Based on the calculation of the assessment of learning devices above, the interval for the validity criteria of learning devices is obtained in Table 3 below:

Table 3. Expert Test Validity Level Criteria

Coefficient of Validity	Level of Validity	Criteria
>0,8	High	Valid
0,4 - 0,8	Medium	Quite valid
<0,4	Very low	Less valid

Learning tools are said to be valid if the validation results of the expert team reach at least a valid level with criteria of 0.4-0.8 In addition, the validators used in this study amounted to 3 people consisting of material experts and media experts.

2. Test the Practicality of Learning Tools

   The practicality test of learning tools is obtained from observation of the implementation of learning and observation of student activities. Observations were made during the learning process with a total of 3 online meetings through Microsoft Teams. The following is the formula used in calculating the results of student responses, namely (Irsalina & Dwiningsih, 2018):

$$P = \frac{\text{Number of scores obtained}}{\text{Maximum number of scores}} x100\%$$

The criteria used in decision making are as follows:

Table 4. Implementation Observation Criteria

Implementation Percentage	Implementation Categories
$85{,}01\% - 100\%$	Very practical
$75{,}01\% - 85\%$	Practical
$65{,}01\% - 75\%$	Quite practical
$50{,}01\% - 65\%$	Less practical
$< 50\%$	Very impractical

Based on the practicality percentage formula, the device is said to be practical based on the implementation of learning and student activities if the percentage of learning implementation and student activity reaches at least 75.01% - 85.00%.

3. Test the Effectiveness of Learning Tools

Test the effectiveness of learning devices obtained from the results of student assessments and learning outcomes tests. In this case, several tests are used to determine the effectiveness of learning using blended learning, namely:

1) Normality Test

This test is used to assess whether the distributed value is normal or not (Priyastama, 2017). In this study the test used was the Shapiro Wilk test, because the amount of data involved was small. In this example, there are criteria that are interpreted as follows in tabular form.

Table 5. Criteria Normality Test

Percentage Score (%)	Interpretation
/P-value/Sig<0,05	Abnormal
/P-value/Sig≥0,05	Normal

2) Homogeneity Test

This test is used to assess whether or not there is the same variance of the data population; if the significant value is greater than 0.05, the variance of two or more groups is equal (Mulianti et al., 2023). In this example, there are criteria that are interpreted as follows in tabular form:

Table 6. Criteria Homogeneity Test

Value Sig	Interpretation
Sig.<0,05	inhomogeneous
Sig.≥0,05	homogeneous

3) N-Gain Test

The N-Gain test is a link between the value before and the value after learning, the N-Gain test is used to find out how the results of the increase occur in high, medium or low. The N-Gain formula used according to the meltzer is as follows:

$$\text{N-Gain}=\frac{\text{score post test-score pre test}}{\text{score ideal-score pre test}}$$

In this example, there are criteria that are then interpreted as follows in tabular form:

Table 7. Criteria N-Gain Test

Value N – Gain	Categories
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Medium
$g < 0{,}3$	Low

4) Test the Hypothesis

The determination of the hypothesis test depends on the results of the prerequisite test. If the data is normal and homogeneous, you can use a parametric test using the t-test used by researchers, namely the Independent Samples T-Test on SPSS 25 software. While non-parametric tests are carried out when one or all test steps cannot be met, non-parametric test steps are needed. The non-parametric test used is the Mann-Whitney test with the help of SPSS 25 software. The Mann-Whitney test can be used for interval or ratio scales. According to Lestari & Yudhanegara (2015), the mann-whitney test is used for statistical data analysis of two independent samples if the type of data to be analyzed is ordinal, interval, or ratio. So researchers can use this mann-whitney test because the data in this study is data on students' higher-order thinking skills tests obtained from experimental classes and control classes with interval scale data.

The Mann-Whitney test formula used in this study is as follows (Lestari & Yudhanegara, 2015):

$$Z_{hitung} = \frac{\sum R(X_1) - n_1\left(\frac{n+1}{2}\right)}{\sqrt{\frac{n_1 n_2}{N(N-1)}\left[\sum R\,(X_1)^2 + \sum R\,(X_2)^2\right] - \frac{n_1 n_2 (N+1)^2}{4(N+1)}}}$$

Information :

$\mathrm{R(X_1)} = \text{Rank untuk } \mathrm{X_1}$

$\mathrm{R(X_2)} = \text{Rank untuk } \mathrm{X_2}$

$\mathrm{N} = \mathrm{n_1} + \mathrm{n_2}$

3. RESULTS AND DISCUSSION

3.1. Results

The results of high-level mathematical reasoning ability tests and learning motivation questionnaires which are quantitative research data, as well as observational findings of learning implementation which are qualitative research data, are obtained from research that has been conducted. Three results will be listed below:

Higher Order Thinking Skills

Results from examinations of students' higher-order thinking abilities and motivation to study math were used to evaluate the efficacy of blended learning using Microsoft Teams. The following exams are used to gauge higher-order cognitive abilities:

1) Normality test

Table 8. Summary of Normality Test

		Kolmogorov-Smimov			**Shapiro-Wilk**		
Ngain_Score_Persen	Kelas	Statistic	Df	Sig.	Statistic	df	Sig.
	Eksperimen	0,117	36	0,200	0,966	36	0,316
	Kontrol	0,123	36	0,190	0,896	36	0,003

*. This is a lower bound of the true signifance

Lillefors Significance Correction

Table 8 shows that experimental and control class data tested using the Shapiro-Wilk test with a significance level of 5% are data that are not normally distributed because the control class has a sig value of 0.05. Therefore, the higher-order thinking ability test is not yet qualified or not normally distributed.

2) Homogeneity Test

Table 9. Homogeneity Test Results

Ngain_Score		**Levene Statistics**	**df1**	**df2**	**Sig.**
	Based on Means	11,383	1	70	0.001
	Based on Median	9,330	1	70	0.003
	Based on Median and with adjusted df	9,330	1	49,281	0.004
	Based on trimmed mean	10.002	1	70	0.002

As shown in Table 2, the results of the homogeneity test using the Levene test procedure with a significance threshold of 5% obtained sig values of 0.001, 0.003, 0.004 and 0.002. Because the higher order thinking ability test does not meet the standard or is not homogeneous, it can be concluded that the sig value of 0.05 is not significant.

3) N-Gain Test

Table 10. N-Gain Test Results

N-Gain	**Experiment**	**Control**
Pretest score	47,78	47,36
Posttest score	82,9	70
Ideal Score	100	100
Results n Group Gain	0,67	0,43
Category	Currently	Currently

The experimental class, which makes use of Microsoft Teams, has an N-gain value of 0.67, which places it in the medium group, while the control class, which does not make use of Microsoft Teams, has an N-gain value of 0.43, which also places it in the medium

group. Therefore, using Microsoft Teams and the blended learning paradigm to enhance higher order thinking abilities (HOTS) in a mathematics course is categorized as being in the moderate group.

4) Mann-Whitney test

Table 11. Mann-Whitney Test Results

Test Statistics[a]	
	Ngain_Score_Persen
Mann Whitney	275,000
Wilcoxon W	941,000
Z	-4,204
Asymp. Sig.(2-tailed)	0.000
a.Grouping Variable : class	

As demonstrated by Asymp Table 7. Sig. (2-tailed) is 0.000 < 0.05. Because of this, it may be said that there is a difference in the outcomes for higher order thinking skills between the experimental and control groups. The results show that learning has an effect on the development of higher order thinking skills, whether it is done through a blended learning model utilizing Microsoft Teams or just through traditional learning, according to the substantial differences.

Results of the Mathematics Learning Motivation Questionnaire

Respondents in this study were 72 high school students in class XI IPS 3 and 4. Based on the results of the students' mathematics learning motivation questionnaire, it can be concluded that the largest percentage before learning was 72.56%, the lowest percentage was 59.26%, and the highest percentage after learning was 82%, the lowest percentage is 69.07%. The questionnaire was provided by paper leaflets which the recipient filled out in person. The following table shows the calculated questionnaire data, which have been combined into one data set:

Table 12. Recapitulation of Student Motivation Questionnaire Before Learning Mathematics

Indicator	Percentage	Category
Desire and the desire to succeed are present	59.26%	Enough
There is motivation	68.33%	Good
Future aims and hopes are present	72.56%	Good
There is a value placed on education	70.69%	Good
There are intriguing things to do	67.50%	Good
There is a favorable circumstance	66.48%	Good
Average	67,470%	Good

Table 13. Recapitulation of Student Motivation Questionnaire After Learning Mathematics

Indicator	Percentage	Category
Desire and the desire to succeed are present	81.94%	Very good
There is motivation	82%	Very good

Indicator	Percentage	Category
Future aims and hopes are present	78.89%	Good
There is a value placed on education	74.31%	Good
There are intriguing things to do	72.22%	Good
There is a favorable circumstance	69.07%	Good
Average	76.405%	Good

Tables 5 and 6 provide the findings from the recapitulation of the students' mathematics learning motivation questionnaire, with an initial average of 67.470% and a final average of 76.405% with each good criterion. It may be argued that using Microsoft Teams and the blended learning model in the classroom boosts students' motivation to learn mathematics.

Observation Results of Learning Implementation

Three online sessions were held for study. Observation of the implementation of learning is carried out at each meeting, with the aim of knowing the feasibility of blended learning applied using Microsoft Teams. The following table shows the results of calculating the implementation observation sheet:

Table 14. Recapitulation of Implementation Observation Sheet

No	Meeting	Percentage	Criteria
1	The first meeting	85%	Practical
2	Second meeting	89%	Practical
3	Third meeting	94%	Very practical
	Average	89%	Practical

89% of students utilize Microsoft Teams to enhance their higher-order thinking abilities and their love of learning mathematics, according to practical criteria.

Validator verification results

In this study, it was stated that there were 3 experts who became validators to check the feasibility of learning devices used before the research took place. The following are the results of the validity of learning tools by 3 experts:

Material expert validation 1 =D(A+B+C+D)=15(0+0+0+15)=1515=1,00
Material expert validation 2 =D(A+B+C+D)=15(0+0+0+15)=1515=1,00
Media expert validation =D(A+B+C+D)=10(0+0+0+10)=1010=1,00

Furthermore, the results of the validity calculation are converted to the table of criteria for the level of validity of expert tests. The results showed that the validity level with a validity coefficient of 1.00 was at the "High" level. This indicates that the learning design on Microsoft Teams media is valid / suitable for use in mathematics learning.

3.2. Discussion

Based on research that has been conducted on improving students' higher-order thinking skills and motivation to learn mathematics at SMAN 3 Cirebon through a blended learning model using Microsoft Teams, the method of reviewing data is to pay attention to the results of obtaining numbers from asking students to fill in pretest and posttest questions and the value of obtaining these numbers that have been produced in the research results.

To further analyze the improvement of higher order thinking skills and student learning motivation through Microsoft Teams assisted blended learning at SMAN 3 Cirebon, the results of the calculation of the assessment results have also been started by providing pretest and posttest results, consisting of 15 pretest questions. Then, 15 posttest questions are given to students. Improving higher-order thinking skills and student learning motivation through a blended learning model using Microsoft Teams at SMAN 3 Cirebon can be seen in the results of obtaining mathematics learning so that it can increase or decrease for students with its presence, based on the results of research that has been conducted to be able to explain and understand the Improvement of High Order Thinking Ability and Student Motivation through a blended learning model using Microsoft Teams at SMAN 3 Cirebon.

Before explaining the results of learning effectiveness, first explain the results of the validity of learning tools and the practicality of learning tools. According to the explanation table above, the results of the validity of learning tools obtained from 3 experts, namely 1.00 with high categories. In addition, the results of observations conducted during 3 online meetings through Microsoft Teams found that 89% of students use Microsoft Teams to improve their higher-order thinking skills and their excitement to learn mathematics.

In addition, the use of blended learning models with the help of Microsoft Teams can help improve higher-order thinking skills and student motivation, and problem-solving techniques in the explanation of mathematical concepts can develop learners and improve. In addition, it has been shown that evidence of pre-posttest results in the control class and pre-posttest scores in the experimental class can be used to provide knowledge data on mathematical ideas by class XII social studies students at SMAN 3 Cirebon for the 2022/2023 Learning Year. This can be seen based on existing data such as summing the results of questionnaire scores and tests that have been taken based on assessment scores. The calculation of the researchers' scores was also preceded by the provision of a test with 15 questions to measure students' higher-order thinking skills through blended learning using Microsoft Teams.

According to the results of the study, there was 0.43 significant improvement in higher-order thinking skills for the control class and 0.67 for the experimental class in mathematics, placing both classes in the medium category, through blended learning assisted by Microsoft Teams at SMAN 3 Cirebon In addition, there was an increase in student learning motivation, which had an average before learning occurred of 67.470 percent and an average after learning occurred of 76.40 percent, all of which met the good criteria.

In addition, the results of research that have been carried out are in line with several studies, namely the results of research conducted by Prayitno & Masduki, (2017) Stating that both material and media experts who validate blended learning design products provide average validation scores of 90.5 and 92.5, indicating that these products are suitable for use in mathematics II education courses at open universities. Furthermore, the results of research conducted by Ekawati & Ristia (2019) stated that students' higher-order thinking skills improved as a result of the use of maple software in blended learning. The students' high-order thinking skills score before learning was 52.94, and their high-level thinking score after learning was 87.84, Recent studies supporting research conducted by Wirza & Ofionto (2021) show that all three teachers have successfully implemented learning with Microsoft Teams, as evidenced by 87% of their inclusion in the Excellent category. Teachers give students assignments and conclusions in the final stage, known as learning evaluation, using the Microsoft Teams assessment tool. 79% of the average at the evaluation stage falls into the good category.

Based on the results of research that are in line with research conducted by researchers, it can be described that research conducted by researchers has an increase in higher-order thinking skills and student motivation through blended learning assisted by Microsoft Teams at SMAN 3 Cirebon

4. CONCLUSION

The application of a blended learning model using Microsoft Teams to increase students' mathematics learning motivation and higher-order thinking skills can be said to be effective because it sees an increase in higher-order thinking skills and mathematics learning motivation where students find it easier to think at a higher level when mathematics learning is carried out using a blended learning approach with the help of Microsoft Teams.

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MATHEMATICS CONNECTION VIEWED FROM ADVERSITY QUOTIENT IN LMS ASSISTED PROBLEM BASED LEARNING IN SMA

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PBL

ABSTRACT

The connection between mathematics and adversity quotient (AQ) is vital in a person's ability to make decisions to solve problems in life. The problem-based learning (PBL) model, assisted by the learning management system (LMS), utilizes technology combining PBL models and LMS-assisted learning. This study aims to (1) examine the effectiveness of LMS-assisted PBL in improving high school students' mathematical connection skills and (2) examine the effect of AQ on students' mathematical connection abilities in LMS-assisted PBL learning. This type of research is a mixed-method research with a sequential explanatory design with a more significant quantitative portion than the qualitative one. The population of this study was class XI students of SMA N 1 Ungaran, Semarang Regency. The research sample was taken using a simple random sampling technique. Qualitative data was taken based on the students' AQ. Quantitative data analysis techniques with parametric statistics include average, classical completeness, and regression tests—qualitative data analysis techniques using data reduction, presentation, and conclusion. The results showed that (1) LMS-assisted PBL learning was effective in increasing students' mathematical connections, and (2) AQ had an influence on students' mathematical connection abilities in LMS-assisted PBL learning.

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1. INTRODUCTION

One goal The State of Indonesia which is listed in the Preamble of the 1945 Constitution is to educate the life of the nation. This goal can be achieved through education which is an important factor for the progress of a nation. Education according to Law No.

20 of 2013 National Education System is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by himself, society, nation and state.

Mathematics is one of the sciences that can help in solving problems. Learning mathematics involves developing strong schemata, which itself requires students to connect related ideas. Students' mathematical connection abilities need to be developed through learning models. The selection of the learning model used must be in accordance with the conditions(Syaiful et al., 2021). The learning model greatly influences the process and learning outcomes(Brinus et al., 2019; Cahyaningrum et al., 2019). PBL is one of the learning models that can facilitate students' mathematical connection skills(Juniati J et al., 2021). Therefore, this study uses the PBL model because it is more flexible when it is applied.

Post-pandemic conditions have changed the way of learning in schools. Many learning activities are now using online and offline. This is a challenge for teachers to plan, implement and evaluate learning. This resulted in learning to continue to utilize communication technology.

Communication technologies such as mobile phones have developed into multifunctional smartphones. The facilities or features provided by smartphones are many and unlimited, such as games, email, social media, learning media, and many more. However, the development of smartphone applications has not been properly addressed by students. The benefits of using smartphones have not been maximized in the world of student education. Smartphones are used more for social media, games both offline and online, and several other applications that do not support student education. The use of smartphones is expected to be more useful in the learning process.

The use of information technology can be implemented in learning to achieve learning objectives more easily and effectively for students. According to Yohannes et al., (2016), learning to use information technology in multimedia is more effective than learning using conventional methods. Learning to use information technology will provide maximum benefits to students in accordance with the times in the era of high use of information technology using the internet(Wardono et al., 2018).

Learning systems that utilize information technology are known as e-learning One learning platform that is widely used by schools in Indonesia is Moodle. The advantage of Moodle is that this application can be used freely as open source, can be accessed for free, teachers can enter teaching materials, assignments, quizzes, and even the results of the exams given. This agrees with(Handayanto et al., 2018), Moodle-based learning can increase student interest, participation, and learning outcomes.

The ability to endure adversity, known as the Adversity Quotient (AQ), is an important aspect of a person's quality of life. AQ can provide a strong motivation for a person to solve the problem at hand, thus supporting the achievement of success(Suryaningrum et al., 2020). Stoltz grouped individuals based on their fighting power into three, namely quitter, camper, and climber. Quitters are people who give up easily, campers are people who feel satisfied with certain achievements, and climbers are people who constantly want to achieve success.

In In fact, research shows that students' mathematical connection skills are low. Research by (Hanarafa & S, 2021; Hati et al., 2022; Kenedi et al., 2019). found that the level of mathematical connection ability of learners is low.

Based on the description above, this study will examine the connection of mathematics to problem-based learning assisted Learning Management System (LMS) in high school.

2. METHOD

This research uses a combination of qualitative and quantitative research (mix methods). The method used is sequential explanatory design, namely this strategy is applied to the collection and analysis of quantitative data in the first stage, followed by the collection and analysis of qualitative data in the second stage, which is built based on the initial quantitative results, where more weight/priority is given to quantitative data (Creswell: 2014)

The population of this study was all grade XI students of SMA N 1 Ungaran, Semarang Regency. The sample of this study consisted of 64 class XI social studies students who had taken trigonometry subjects. Research samples taken using simple random sampling techniques are used for sampling. Class XI IPS 2 (Control class) and class XI IPS 1 (Experimental class) are classes used for research. While qualitative data is taken based on students' AQ, namely climber, camper, and quitter categories. In this study, the independent variable is Adversity Quotienty when using the LMS-assisted problem-based learning paradigm. While mathematical connections are the dependent variable in this study. The research instruments used include the Adversity Quotienty questionnaire and mathematical connection test questions.. Quantitative data analysis techniques in this study used average tests, classical due diligence, and regression tests. Qualitative data analysis techniques use data reduction, presentation, and conclusions.

This questionnaire was used to measure the level of Adversity Quotienty (AQ) where in this study there were 3 categories, namely quitters, campers, and climbers. This is described in the following table (Mafulah & Amin, 2020):

Table 1. Indicator AQ

Score	AQ Level Categories
<59	Quitters
60-94	Switching quitters (QT) to campers (CP)
95-134	campers
135-165	Transition of campers (CP) to climbers (CB)
>165	Climber

In addition, to measure the mathematical connection test in this study using several tests, including:

1) Normality test
2) Homogeneity test
3) Average difference test using the t test.
4) Classical Due Diligence

Classical completeness testing is used to determine whether the percentage of students in LMS-assisted problem-based learning who achieve individual completeness reaches 75%. The statistical hypothesis is as follows.

H_0: $\pi \leq 75\%$ (The proportion of mathematical connection skills of students taught with LMS-assisted problem-based learning that achieve completeness has not reached at least 75%).

H_1: $\pi > 75\%$ (The proportion of mathematical connection skills of students taught with LMS-assisted problem-based learning that achieve completeness has reached at least 75%).

The test criterion is H_0 is accepted if the Zcalculate value is $\leq Z(0{,}5-\alpha)$. The formula used is as follows :

$$z = \frac{\frac{x}{n} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$$

Information :
z : Calculated z-value
x : the number of students who complete individually
π_0 : hypothesized value
n : number of sample members

3. RESULTS AND DISCUSSION

The results of research on mathematical connections in terms of AQ of students in LMS-assisted PBL, namely the quantitative stage and the qualitative stage which aim to answer the problem formulation. The quantitative stage in this study will describe the results of the average student analysis, classical completeness, and the influence of students' AQ on mathematical connections. The results of the analysis of this quantitative stage aims to test the hypotheses in this study. Before carrying out several tests related to the hypothesis, the normality and homogeneity tests are carried out first.

3.1. Quantitative Data Analysis

Before testing the data into the normality test, the descriptive table will be presented first, which is as follows:

Table 2. Descriptive Statistical Test Results

Descriptive Statistics					
Statistic	N	Minimum	Maximum	Mean	Std. Deviation
Pretest_Eks	32	24	65	47.78	11.714
Posttest_Eks	32	24	82	57.44	14.402
Pretest_Kontrol	32	24	53	35.16	10.445
Posttest_Kontrol	32	18	76	46.81	15.192
Valid N	32				

In table 2 above, it can be seen that the experimental class pretest and posttest variables have the lowest value of 24 and the highest value of 82 with their average values of 47.78 and 57.44 and their standard deviations (data distribution rates) of 11.714 and 14.402. The control class pretest and posttest variables had the lowest values of 18 and 24 while the highest values were 53 and 76 with average values of 35.16 and 46.81.

3.1.1. Normality test

Table 3. Data Normality Test Results

Class	Sig.	Information
Eksperimen	0,200	Normal distributed data
Control	0,200	Normal distributed data

Based on the table above, the sig values of the two classes are 0.200 and 0.200 so that the sig values of the two classes are more than 5%, then H_0 is accepted, meaning that the final data comes from a normally distributed population. So, the sample comes from a normally distributed population sig value

3.1.2. Homogeneity test

Table 4. Data Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Score	Based on Mean	2.626	1	62	.110
Test	Based on Median	2.636	1	62	.110
	Based on Median and with adjusted df	2.636	1	59.354	.110
	Based on trimmed mean	2.700	1	62	.105

Based on the table above, sig values of 0.110, 0.110, 0.110 and 0.105> 0.05 are obtained. Since the sig value is more than 5% then H0 is accepted, this indicates that the variance of the experimental class is equal to the variance of the control class.

3.1.3. Hypothesis Test 1 (Test of Average Mathematical Connection Ability)

Table 5 Average Test Results for Mathematical Connection Ability

	N	Mean	Std. Deviation	t	Sig.(2-tailed)
TKKM_Eks	32	.6889	.22306	8.200	0.000
TKKM_Kontrol	32	.1520	.29574	8.200	0.000

Based on the results calculation with formula t,earned value t_{hitung} = 8,200> 1.746 = t_{tabel} then H_0 is rejected. That is, the average mathematical connection ability of students given LMS-assisted problem-based learning is better or equal to the average mathematical connection ability given problem-based learning.

3.1.4. Hypothesis Test 2 (Classical Completeness of Mathematical Connection Ability)

Table 6. Results of the Experiment Class Classical Completeness Test

Class	X	n	π_0	z_{count}	$z_{(0,5-\alpha)}$	Criteria	Results
Eks	30	32	0,75	2,467	0,1736	$z_{hitung} > z_{tabel}$	H_0 rejected
Control	25	32	0,75	4,111	0,1736	$z_{hitung} > z_{tabel}$	H_0 rejected

Based on table 6, the z_{hitung} value in the experimental class was 2.467 > 0.196 and in the control class the z_{tabel} value was 4.111, then **H_0** was rejected. That is, more than 75% of

the final test results of students' mathematical connection abilities in LMS-assisted Problem-based learning are declared complete and achieve classical completeness.

3.2 Subject Determination Based on AQ

Subject determination based on AQ is divided into three categories, namely climber, camper, and quitter. The grouping of participants based on AQ was carried out before and during the implementation of the learning process. The data used in determining this subject is from the results of the AQ questionnaire. The grouping of subjects and the percentage of students based on the AQ questionnaire can be seen in table 7.

Table 7. Grouping of Subjects and Percentage of Students Based on the AQ Questionnaire

Category	Many Students	Percentage (%)
Climbers	4	22%
Campers	10	56%
Quitters	4	22%
Amount	18	100%

Based on the grouping of subjects from the results of the AQ questionnaire, two subjects from each category were selected to be interviewed regarding students' mathematical connection abilities. This aims to clarify the existence of a relationship between AQ and students' mathematical connection abilities. Sampling from each level of student AQ was carried out using a proportionate stratified random sampling technique, namely taking samples of data sources based on proportions. The selection of the sample was based on certain characteristics that were considered to have something to do with the population characteristics that were previously known and based on the recommendations from the class XI IPS teacher.

3.2.1 Mathematical Connection Ability with AQ Climber

Students who have AQ climber categories are 9 (nine) students, namely A17, A2, A15, A22, A12, A20, A24, A16, and A10. The percentage of students who have AQ climber category is 80.22% of the total number of experimental class students. The results of the learners' math connection ability test are shown in table 8.

Table 8. Test Results of Students' Mathematical Connection Ability with AQ Climber

No	Code	Adversity Quotient Score	TKKM score
1	A17	161	80
2	A2	155	79
3	A16	149	81
4	A10	148	79
5	A22	157	82
6	A12	154	81
7	A20	151	78
8	A24	153	80
9	A15	149	82
Average		**153**	**80,22**

Based on table 7 it can be seen that learners with AQ climber scores have quite high mathematical connection abilities, namely 78 to 82 with an average of 80.22. This means that the ability of students' mathematical connections with AQ climbers has reached completion.

3.2.2 Mathematical Connection Ability with AQ Camper

Students who have AQ climber category as many as 17 students namely A1, A3, A5, A7, A9, A11, A13, A18, A19, A21, A23, A26, A27, A28, A29, A30, and A31 with the percentage of students who have AQ climber category is 53.125% of the total number of experimental class students. The results of the learners' math connection ability test are shown in the table 9.

Table 9 Test Results of Students' Mathematical Connection Ability with AQ Camper

No	Code	Adversity Quotient Score	TKKM score
1	A1	95	69
2	A3	97	68
3	A5	95	70
4	A7	96	68
5	A9	101	68
6	A11	102	70
7	A13	98	65
8	A18	97	67
9	A19	96	69
10	A21	99	67
11	A23	105	69
12	A26	110	72
13	A27	102	70
14	A28	108	65
15	A29	115	70
16	A30	130	68
17	A31	125	70
Average		**1771**	**68,52**

Based on the table, it can be seen that learners with AQ camper scores have sufficient mathematical connection abilities, namely 65 to 72 with an average of 68.52. This means that students with AQ Camper are able to complete the math connection ability test well, but campers students do not re-examine the completion that has been obtained because they are satisfied with the results.

3.2.3 Mathematical Connection Ability with AQ Quitter

Students who have AQ climber categories are 6 (nine) students, namely A4, A6, A8, A14, A25, and A32. The percentage of students who have the AQ Quitter category is 18.75% of the total number of experimental class students. The results of the learners' math connection ability test are shown in the table 10.

Table 10 Test Results of Students' Mathematical Connection Ability with AQ Quitter

No	Code	Adversity Quotient Score	TKKM score
1	A4	45	40
2	A6	40	56
3	A8	48	59
4	A14	58	48
5	A25	55	50
6	A32	50	52
Average		**296**	**50,83**

Based on the table 10, it can be seen that students with AQ camper scores have sufficient mathematical connection abilities, namely 40 to 58 with an average tkkm score of 50.83. This means that students with AQ Camper are able to complete math connection ability tests well but quitter students cannot solve problems with correct answers..

3.3. Qualitative Data Analysis

In this study, connection ability was described based on the AQ category, namely climber, camper, quitter on four components of mathematical connections, namely connections in the same material, connections between topics in mathematics, connections between subjects, and connections with the real world. There are 9 students belonging to the AQ climber category, 17 students belonging to the AQ camper category, and 6 students belonging to the AQ quitter category. The climber and quitter categories were taken by 2 students, while the camper was taken by 2 students who were selected as qualitative research subjects to describe their connection abilities.

In general, learners belonging to the AQ climber group have excellent mathematical connection skills. Learners with an AQ climber can master the four components of mathematical connections very well. In addition, climbers have relatively high scores on aspects of control, origin & ownership, reach and endurance. Because they have a good control score, students increasingly master the situation when facing problems

Furthermore, students who belong to the AQ Camper group can solve problems with the right answers. However, they did not re-examine the settlement that had been obtained because they were satisfied with the results. This can cause them not to realize any errors in the resolution. Learners with AQ Camper have sufficient ability to solve problems. However, they have high self-confidence and tend to feel satisfied with the results they have achieved. This can cause them to be unmotivated to continue learning and improving their abilities.

On the other hand, learners with AQ Quitter cannot solve problems with the right answers. This can be caused by several factors, such as lack of understanding of the material, lack of critical thinking skills, or lack of motivation. Learners with AQ Quitter tend to give up easily when faced with challenges. They also have low self-confidence and tend to blame conditions or others for their failures.

Based on the description above, it shows that in solving mathematical problems, each subject who has high AQ levels (climbers), medium (campers), and low (quitters) has different mathematical connection abilities. This is in line with Irianti (2017) in a research she conducted that each of the three levels of AQ has its own characteristics in solving a problem. It is influenced by the character of the students for each level. Yoga (2016) distinguishes the personalities of climbers, campers, and quitters in his book. This character then affects the mathematical connection ability of each student in solving problems. Based

on this discussion, it can also be seen that the level of Adversity Quotient (AQ) owned by students affects students' mathematical connection ability in solving mathematical problems.

3.4. Quantitative anf Qualitative

Gunawan, (2011) states that the quality of a learning product is inseparable from the quality of the learning program and the learning process itself. In improving the quality of learning, the role of the teacher becomes important. The quality of learning in this study was reviewed quantitatively and qualitatively. A good learning program is of course inseparable from good learning tools. It is supported byRahmadi, (2015) which states that a learning device is said to be valid if it is at least in the good category so that the device is suitable for use.

At the assessment stage the researcher gave a test of students' mathematical connection abilities and an AQ questionnaire. At the assessment stage, the researcher also analyzed the test results of students' mathematical connection abilities. The researcher gave an initial mathematical connection ability test. The results of the initial mathematical connection ability test showed that the average mathematical connection ability of the experimental and control class students in solving math connection ability questions was almost the same. Based on the homogeneity test, information was obtained that the two classes had a homogeneous variance. Based on the average similarity test, it was concluded that the average test ability of the experimental and control class students in solving problems was not significantly different.

After the experimental class was given LMS-assisted PBL learning, it was followed by giving a math connection ability test. Then the TKKM results in the experimental class were tested for completeness. Students who were taught using LMS-assisted PBL on average completed KKM, the classical completeness test showed that the proportion of experimental class students who scored a minimum of 65 had exceeded 75%. Besides that, based on a review from AQ, AQ climbers have the best connection skills in the LMS-assisted problem-based learning model in high school.

4. CONCLUSION

Based on the results of the analysis of the results and discussion, the research conducted quantitatively and qualitatively is mutually reinforcing. Therefore, the conclusions of this study are:

a. LMS-assisted PBL learning is effective in increasing students' mathematical connections because:
   1) The mathematical connection abilities of students who receive problem-based learning assisted by the LMS average exceed the Minimum Completeness Criteria (KKM).
   2) The mathematical connection abilities of students who receive LMS-assisted problem-based learning can achieve classical mastery.
b. There is a significant effect of students' AQ on the ability of mathematical connections in LMS-assisted problem-based learning.

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MATHEMATICAL REPRESENTATIONS BASED ON FIELD-DEPENDENT AND FIELD-INDEPENDENT COGNITIVE STYLES

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ABSTRACT

Mathematical representation ability is essential for students, but many students still need to be able to solve mathematical problems with various mathematical representation abilities. This research is narrative research with a qualitative approach to describe the problems of students' mathematical representation abilities in terms of field-dependent and field-independent cognitive styles on the set topic. A total of 4 students, based on the GEFT test and the results of the subject teacher's directions, tended to field-dependent and field-independent cognitive styles. The instruments used in this study were the GEFT test, questions of representation ability, and interview guidelines. The results of the data analysis show that the mathematical representation abilities of students with a field-dependent cognitive style can be represented with several models. In contrast, the mathematical representation abilities of students with a field-independent cognitive style can represent all indicators. Based on these conditions, the teacher can plan a differentiated lesson in the learning process by paying attention to the differences in students' cognitive styles.

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1. INTRODUCTION

Representational ability is one of the student abilities used to help students understand ideas in mathematics (Kwon & Capraro, 2021). Students need mathematical representation abilities to understand mathematics and to construct abstract knowledge into concrete knowledge through logical thinking (Goldin, 2014). Mathematical representation ability is the ability to express mathematics through symbols, pictures or graphs, numbers, and words to solve mathematical problems (Ratumanan et al., 2022). Students are said to

have good mathematical representation skills when using various models to solve mathematical problems.

Mathematical representation ability can be described by four categories of representation which are identified as verbal, numerical, pictorial or pictorial, and algebraic (Nurrahmawati et al., 2021). Students usually use verbal representations to state the problem at the beginning and provide a final interpretation of the answers found in solving the problem. Numerical representation is used to represent the numbers at the solution. Pictorial or image representation is the ability to solve problems with pictures, graphs, or diagrams. *Algebraic representation* is an expression that is expressed through an example with variables to model solving mathematical problems. Indicators in this study, the ability of representation can be seen from 1) the ability to present answers through pictures or diagrams, 2) present answers through mathematical symbols, 3) present answers through numbers, 4) present answers through verbal or words (Friedlander & Tabach, 2001; Nadira et al., 2023).

The set is one material that shows various kinds of mathematical representations (Sari & Sutirna, 2022). The ability of image representation can be shown through Venn diagrams, symbol representation can be shown through set notation, numerical representation can be shown in set operations, and verbal representation can be shown through words explaining the set situation. However, several studies show that many students still need help using various mathematical representations to solve problems about sets (Wati et al., 2019; Wulandari et al., 2019). This research shows the need for teachers to develop students' mathematical representation skills so that students can solve mathematical problems appropriately.

Each student will have different ways and patterns of thinking when expressing a mathematical understanding of a mathematical problem (Tiew et al., 2023), so each student will have different representation abilities. One factor that differentiates students when presenting the results of answers to math problems is the cognitive style of students (Sellah et al., 2017; Spector, 2012). Cognitive style is a person's habit, a way of thinking that is common or preferred to understand information, process information, and apply information (Hayes & Allinson, 1994). Cognitive style is a person's thinking ability to process, store and use to respond to information (Bassey et al., 2009; Ratuanik, 2018). *Cognitive style* is a variable that teachers must pay attention to in designing learning because cognitive style can influence the way students learn and the way students interact with teachers in the classroom (Bintoro et al., 2022).

This research centers on the examination of mathematical representation proficiency with a focus on field-dependent (FD) and field-independent (FI) cognitive styles. The impact of FI and FD becomes evident in the manner in which students approach mathematical problem-solving, thereby influencing their overall mathematical representation capabilities(Septian et al., 2020). FD characterizes a cognitive style wherein a student's thought processes are notably susceptible to external influences. Conversely, FI reflects a cognitive style in which a student adeptly processes information without being swayed by external factors (Witkin et al., 1977). By discerning students' cognitive styles, it is anticipated that educators can gain insights into their initial competencies, enabling them to tailor instructional content in alignment with students' cognitive preferences before disseminating the material. This approach ensures that learning objectives are effectively communicated to students in accordance with their cognitive styles (Guisande et al., 2007).

So far, much research has been done on mathematical representation abilities in terms of cognitive style (Himmah & Rahaju, 2021; Khairunnisa & Masrukan, 2020). However, there has yet to be an explanation of the characteristics of mathematical representation abilities in students' FI and FD cognitive styles in solving mathematical problems on set. So

the purpose of this study was to determine the characteristics of mathematical representation ability in terms of students' cognitive style.

Along with implementing a new curriculum in Indonesia called Merdeka Curriculum, the Integrated Bilingual Middle School was chosen as the driving school that implemented the independent curriculum. One of the learning approaches to the independent curriculum is differentiation learning. *Differentiated learning* is a learning approach that the teacher carries out by adjusting learning activities based on each student's learning abilities, interests, and student profile (Tomlinson, 2001). So through differences in student profiles seen from cognitive styles, teachers can provide appropriate learning services to develop students' mathematical representation abilities fully.

2. METHOD

This narrative research uses a qualitative approach (Creswell, 2008). This study aims to describe the characteristics of mathematical representation abilities in terms of students' cognitive style on set material. This research was conducted at the Krian Integrated Bilingual Middle School, Sidoarjo, on 3-30 May 2023. The data collection techniques in this study were cognitive style tests, representation ability tests, and interviews. The research instrument used to collect data about students' cognitive styles uses the Group Embedded Figure Test (GEFT) test developed by Witkin. The mathematical representation ability test is given through questions from the set material as much as three questions. ~~as 1 question.~~ In comparison, the interviews were conducted through interview guidelines.

The GEFT test consists of three groups of questions where the first group of questions consists of 7 items, and the second and third groups of questions each consist of 9 items. The first group of questions is given as an exercise for respondents to understand how the test works so it does not affect the score. Meanwhile, when students work on the second and third groups of questions, students will get a score. Students who answered correctly were given a score of 1; if they answered incorrectly, they were given a score of 0. For the first group of questions, they were given 5 minutes, then for the second and third groups of questions; they were each given 9 minutes.

This study's subjects were twenty Integrated Bilingual Junior High School students in class VIII-H who took the cognitive style test. After twenty students carried out the GEFT test, the participants were categorized into field-dependent, field-independent, and ambiverts (not dependent on FI and FD). Grouping calculations are based on the value of M ± standard deviation as a cut-off point (can be seen in Figure 1), where the value of M ± standard deviation is determined from the scores of twenty students (Setiawan et al., 2020).

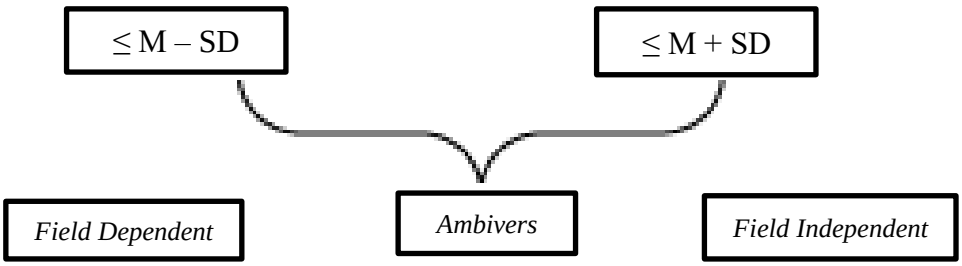

Figure 1. Cognitive style category (M: mean, SD: Standard Deviation)

Figure 1 shows that if students score less than or equal to M – SD, they are in the field-dependent category. If students are at a value greater than or equal to M + SD, they are in the independent field category. Apart from these values, they are classified as ambivert or do not experience a tendency towards field-dependent and field-independent cognitive styles

(Setiawan et al., 2020). After the students completed the GEFT test, they were given questions to test their ability to represent the set topic mathematically. The indicators of mathematical representation ability can be seen in Table 1.

Table 1. Mathematical Representation Indicator

Representation	Rated aspect	Student Responses	Score
Visual	Presenting answers through pictures, graphs or tables	Does not involve a visual representation to clarify the problem	0
		Inappropriate or incorrect visual representation	1
		The visual representation is appropriate or true	2
Symbol	Presenting answers using mathematical symbols or mathematical models	Does not state symbols or mathematical models	0
		Stating a mathematical symbol or model incorrectly	1
		Stating symbols or mathematical models correctly	2
Numeric	Present answers using numbers	Does not state the number to answer	0
		Stating a number in the answer but wrong	1
		State the number in the correct answer	2
Verbal	Present the answer in a word or sentence	There is no conclusion in the form of a sentence	0
		There is a conclusion in the form of a sentence, but it is wrong	1
		There is a conclusion in the form of a correct sentence	2

The grid questions to see students' mathematical representation abilities are as follows:

Table 2. Question Grid

Learning objective	Indicators of Competence Achievement	Question Indicator
Solve contextual problems related to the characteristics of sets, types of sets, set operations, set relations, and venn diagrams.	Solve problems related to set operations	From the data of 25 students of class VIII-B, it is known that 20 students like drinking coffee and 13 students like milk. Determine a. how many students like coffee? b. how many students like milk? c. how many like both?

After conducting the representation ability test, researchers conducted interviews with subjects S1 and S2 who tend to have a field dependent cognitive style and S3 and S4 subjects who tend to have a field independent cognitive style. Interviews are used as data reinforcement to analyse the overall results of the test. The interview grids are as follows:

Table 3. Mathematical representation skills interview grid

Indicator	Question
Understand the problem	1. How did you feel after solving the problem? 2. How do you try to understand the problem?
Plan problem solving	3. What are the steps to answer the question?
Problem-solving	4. Is the way to complete the answer as taught by your teacher? 5. Are there pictures, symbols, numbers, and words?
Make a conclusion	6. Did you conclude your answer? 7. Are you used to making conclusions with words?

To analyze the data, it was done by means of triangulation of data from field-dependent and field-independent cognitive style grouping test data. The results of mathematical representation ability tests and interview data were analyzed through Nviovo 12 Pro software. The results draw conclusions to answer the research objectives.

3. RESULTS AND DISCUSSION

3.1. Results

Based on the results of the cognitive style test through the GEFT test of 20 students in class VIII-H of the Integrated Bilingual Middle School with the groupings in Figure 1, the following data is obtained:

Table 4. GEFT Test Results

Category	The number of students	Subject
Field dependent	2	S1, S2
Ambivers	16	
Field independent	2	S3, S4

Following are the results of the mathematical representation ability test and interviews with the four subjects.

1. **Students' mathematical representation ability with field dependent cognitive style S1.**
   The following are the results of the answers to the mathematical representation ability test questions conducted by S1:

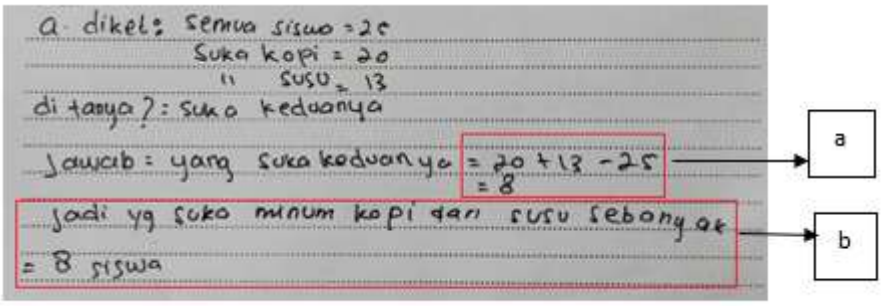

Figure 2. S1 representation ability test results

Figure 2 shows that S1 can answer questions with known writing stages, write what is asked, answer questions correctly, and provide concluding sentences. To solve S1 questions, use the ability of numerical mathematical representations and verbal representations. S1 shows numerical representation ability with the answers in Figure 2a, the numbers to calculate the number of students who like coffee and milk. S1 shows verbal representation ability in Figure 2b by writing words as a conclusion. The results of interviews conducted by researchers with S1 obtained information that S1 can explain the steps to solving set operations questions. S1 conveys a uniqueness in the sixth sentence. Namely, S1 uses a method that is easy to remember through a quick method.

P(1) : "how did you try to answer the question??"
S1(2) : "I answered by writing down what was known, then I answered what was asked"
P(3) : "whether the way to complete the answer according to what was taught by your teacher?"
S1(4) : "hmmm, I'm just writing down the quick method, ustadz, if you give an example in full"
P(5) : "why are you using the fast way?"
S1(6) : "**yes, so that it's simpler, Ustad and remember that I'm just a quick way**"

From the data on the mathematical representation ability test results from Figure 2 and interviews at S1, information was obtained that S1 could solve questions with correct answers. The ability of mathematical representation shows results that lead to the tendency of numerical and verbal representation. So if viewed from the field-dependent cognitive style, the result is that the tendency for mathematical representation abilities is numerical and visual and prefers simple answers or fast ways.

2. The ability of students' mathematical representation with field dependent cognitive style S2.

The following are the results of the answers to the mathematical representation ability test questions conducted by S2:

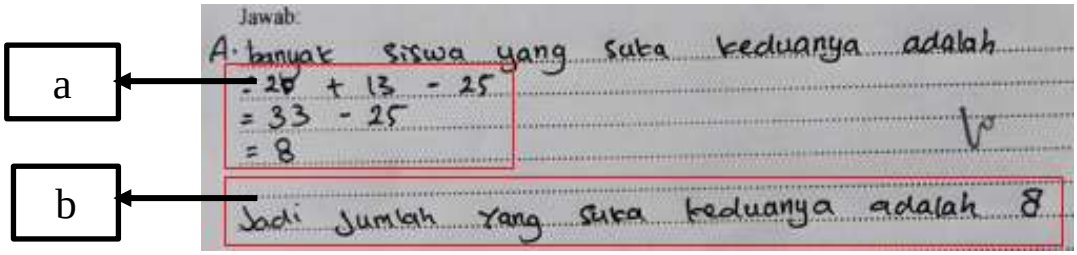

Figure 3. S2 representation ability test results

Figure 3 shows that S2 has answered the representation ability test questions correctly. S1 writes down the answer by showing the numerical representation in Figure 3a and the verbal representation in Figure 3b. The ability of numerical representation can be seen from the numbers to calculate the answers of many students who like coffee and milk. The ability of verbal representation is shown in words in the concluding sentences written in the S2 answers. S2 did not write down the steps to answer math questions from what was known and what was asked. Word in conclusion. The results of interviews with S2 obtained information indicating that S2 could explain the steps for answering questions. However, S2 realized that he was answering questions by directly calculating the results asked. A uniqueness emerges from the interview results, shown in sentence number 8, S1 prefers the fast method for simpler reasons.

P(7) : "why do you prefer the fast way only?
S2(8) : **"because it's easier to answer"**
P(9) : "do you get used to answering questions like that?"
S2(10) : "not really ustad, sometimes I also use the long way if there really is no fast way"

Based on the results of data from Figure 3 and interviews from S2, the result was that S2 was able to answer the mathematical representation ability test questions correctly. These results also show the representation ability with numerical and verbal representation indicators. So if viewed from the field-dependent cognitive style, the results show that mathematical representation capabilities tend to be numerical and visual. Another characteristic is that the field-dependent prefers a quick way to find answers.

3. The ability of students' mathematical representation with field independent cognitive style S3.

The following are the results of the answers to the questions on the mathematical representation ability test conducted by the S3 subject:

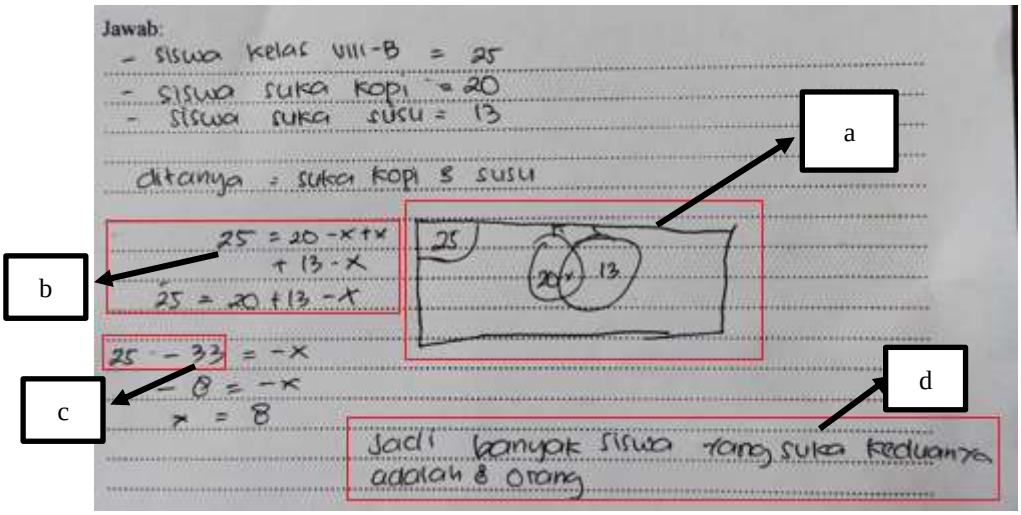

Figure 4. The results of the S3 subject's representation ability test

In Figure 4, the results of the S3 representation ability test showed that the answers were correct, as well as demonstrating visual (4a), symbolic (4b), numerical (4c), and verbal (4d) representation abilities. Visual representation ability, S3 wrote Venn diagrams to answer questions. The subject's symbolic representation ability, S3 writes a mathematical model through algebra by making an example of the variable x. numerical representation ability, the S3 uses numbers to find answers through number operations. In verbal representation ability, S3 subjects make conclusions from the results of the answers. The results of interviews with S3 have described the process of answering questions. Subject S3 explains in a coherent way how to answer questions. In one part of the interview, important information can be seen in sentence 12. The S3 followed the directions exemplified by his teacher when answering the questions. Like the following interview excerpt:

P(11) : "did your teacher teach you that way?"
S3(12) : **"yes"**
P(13) : "at the end of the answer, do you write a conclusion?"
S3(14) : "sure"

Based on the presentation of the results of the S3 subject, it was obtained data that the S3 subject was able to solve the questions correctly. The answers from the S3 subject showed the ability to represent mathematically using four indicators, namely visual, symbolic, numerical and verbal. If viewed from the cognitive style of subject S4 is a subject with a field independent cognitive style with a tendency to use all mathematical representations which include visual, symbolic, numerical and verbal. As well as the independent field cognitive style shows more following the directions exemplified by the teacher.

4. **Students' mathematical representation ability with field independent cognitive style subject S4**

Following are the results of subject S4's answers in answering the mathematical representation ability test.

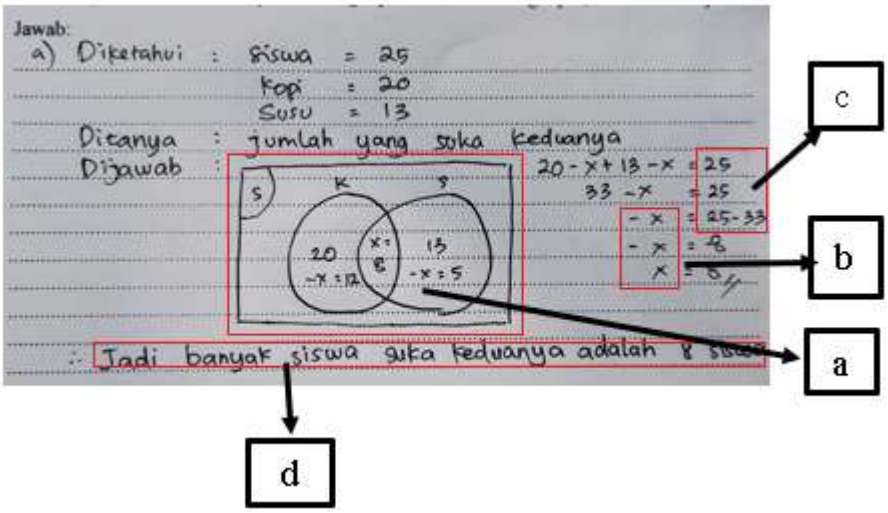

Figure 5. The results of the S4 subject's representation ability test

Figure 5 shows the results of subject S4's answers. It can be seen that the answers are correct and show visual representation (5a), symbolic (5b), numerical (5c), and verbal (5d) representation abilities. The ability of visual representation can be seen in the answers with pictures of Venn diagrams. Symbolic abilities, S3 subjects write algebraic equations with the variable x. Numerical abilities are shown by the numbers in solving equations. The verbal representation ability is shown by writing conclusions with sentences, so the number of students who like both is eight. The interviews with subject S4 showed that subject S4 answered according to the mathematical procedure of knowing, being asked, answering, and so according to written answers. There is important information from the results of subject S4's answers that S4 answered according to what was exemplified by the teacher when answering the questions. This condition is shown in the interview excerpt in the 16th sentence.

P (15) : "did your teacher teach you how to solve it like you did?"
S4 (16) : **"yes, I answered according to the example of my teacher"**

Based on the exposure to the results of subject S4, data was obtained that subject S4 could solve the questions correctly. The answers from subject S4 show the ability to represent mathematically using all four indicators: visual, symbolic, numerical, and verbal. If viewed from the cognitive style of subject S4 is a subject with a field-independent cognitive style with a tendency to use all mathematical representations, which include visual, symbolic, numerical, and verbal, as well as the field-independent cognitive style showing characteristics that follow the conditions taught by the teacher.

3.2. Discussion

The results of the field-dependent and field-independent cognitive style tests, the results of the mathematical representation ability tests, and the results of the interviews can be shown in Table 4.

Table 5. Results of data analysis

Cognitive Style	Mathematical Representation Ability			
	Visual	**Symbol**	**Numeric**	**Verbal**
Field dependent	Not yet able to demonstrate visual representation ability	Not yet able to demonstrate the ability of symbol representation	Can demonstrate numerical representation skills	Can demonstrate numerical representation skills
Field independent	Can demonstrate visual representation skills	Can represent the ability to point to symbols	Can demonstrate numerical representation skills	Can demonstrate verbal representation skills

Table 4 shows that in subjects with field-dependent cognitive styles in answering test questions, representational abilities only appear in numerical and verbal representations but do not generate visual representations and symbols. While subjects with field-dependent cognitive style in answering test questions, mathematical representation abilities show all four indicators, which include visual, symbolic, numerical, and verbal.

Students' mathematical representation abilities in terms of cognitive styles show significant differences, as seen from the findings in this study. Differences in indicators of mathematical representation abilities between field-dependent cognitive styles and field-independent cognitive styles occur due to differences in students' thinking styles (Septian et al., 2020; Widakdo, 2017). Students whose cognitive style is field dependent tend to answer practically so that results are obtained, only sometimes following the method given by the teacher when solving math problems. Meanwhile, the independent field cognitive style in solving mathematical problems imitates what is exemplified by the teacher so that it includes all indicators of representational abilities.

The results of the study show that the ability to solve problems in the independent field cognitive style is more diverse in using mathematical representations, while the field-dependent cognitive style only uses several mathematical representations in solving mathematical problems(Ratuanik, 2018; Rofiq et al., 2021; Yusrina & Masriyah, 2018). In addition, the results of other studies also state that students' cognitive styles are very important to pay attention to in the learning process so that students can solve math problems correctly (Son et al., 2020). So that students' representation abilities can be seen from their modeling abilities as indicated by visual representations and symbols and being able to make interpretations through the form of numerical and verbal representations (NCTM, 2000).

With differences in students' mathematical representation abilities, teachers are expected to be able to prepare learning designs with various kinds of mathematical representation abilities (Prihandhika et al., 2022). Moreover, the teacher also pays attention to the differences in the cognitive style of each student. Students' cognitive style is very important to note in the learning process so that students can solve mathematical problems. This situation is in line with the implementation of the independent curriculum in Indonesia, where in the learning process, the learning approach through differentiated instruction or differentiated learning, teachers can group students based on the teacher's initial abilities and can also group based on field-

dependent and field-independent cognitive styles. So that all students can achieve learning objectives by reviewing the differences in students (Abu Bakar & Ali, 2018; Faradiba, 2019, 2022; Faradiba et al., 2023; Hayes & Allinson, 1994).

4. CONCLUSION

Through data analysis from the results of students' cognitive style tests, tests of students' representation abilities, and interviews conducted at the Integrated Bilingual Middle School Class VIII for the 2022/2023 academic year, it was concluded that mathematical representation abilities with field-dependent cognitive style are good enough to represent questions about the set, because only able to use some indicators of mathematical representation, namely numerical and verbal. Meanwhile, mathematical representation with a field-independent cognitive style is very good at representing the questions about the set because it uses all indicators of mathematical representation, namely visual, symbolic, numeric, and verbal. The development of students' mathematical representation abilities so that they are more developed cannot be separated from the teacher's role as a facilitator to use various mathematical representations when solving mathematical problems to achieve learning goals. Suggestions from this study It is expected that field-dependent and field-independent cognitive styles are used as one factor to see differences in student profiles so that teachers can plan to learn according to the differences of each student so that all students can achieve learning objectives.

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ANALYSIS OF STUDENTS MATHEMATICAL LITERACY ABILITY IN SOLVING PISA PROBLEMS IN TERMS OF STUDENT LEARNING INDEPENDENCE

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ABSTRACT

Mathematical literacy skills are one of the essential aspects that students need to master because, through this ability, they can solve problems in everyday life. Providing *Programme for International Student Assessment* (PISA) questions is one of the teachers' efforts to develop students' mathematical literacy skills. This study aims to describe the observed mathematical literacy ability of students learning independence and analyze the difficulties experienced by students in solving PISA problems. The study subjects consisted of 20 students of SMPN 02 Siak Hulu. The research method used is descriptive. The research instrument is PISA test questions oriented to quantity content, learning independence questionnaires, and interview guidelines. The data obtained is analyzed by reducing, presenting, and drawing conclusions. The result of this study is that students doing PISA questions are still experiencing difficulties. This difficulty occurs because students are unfamiliar with PISA model questions. They do not understand the meaning of the problem, do not understand the material in the problem, are confused about determining mathematical concepts, and cannot apply problem-solving strategies.

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1. INTRODUCTION

The era of the industrial revolution 4.0 demands a change in the context of learning. The paradigm of implementing learning that focuses on the ability to think critically, connect

knowledge with everyday life, communicate and collaborate and participate in using sabila technology, 2022). The 21st century is a time marked by advances in science, technology, information and communication, global competition and free competition so that the basic abilities that students must have are not just counting skills but mathematical thinking and reasoning skills in solving problems and learning new ideas faced by students in the future (Janah et al, 2019). These things are contained in mathematical literacy skills that are important for students to master. Mathematical literacy skills help students to solve problems related to everyday life using mathematical concepts. Mathematical literacy skills include the ability of individuals to reason mathematically, formulate problems, apply concepts, and interpret mathematics to solve various problems in various real-world contexts (Yudi &; Rajab, 2019).

In line with what was expressed by Kusumawardani et al. (2018) Mathematical literacy ability is said to be the ability to formulate, use and interpret mathematics in various real-world problem-solving contexts effectively. Kusniati (2018) explains mathematical literacy skills as mathematical thinking skills that use concepts, procedures, facts, and tools to describe, communicate, and estimate a phenomenon they face.Interpreting the statement above that mathematical literacy ability as the ability to connect relevant mathematical concepts tosolve various problems in the real world. Students who have mathematical literacy skills will tend to be active in learning, able to ask a series of questions, formulate problems in mathematical form, be able to communicate ideas effectively that aim to solve everyday problems (Kamila, 2022). It is important for students to have mathematical literacy skills because this ability makes it easier for students to solve complex problems in the real world effectively. One of the efforts to build students' mathematical literacy skills is by practicing doing context-based math problems and PISA-based problems (*Programme for International Student Assessment*). Understand the importance of mathematical literacy skills as mathematical skills that help solve PISA problems.

PISA classifies students' levels of mathematical literacy ability into 6 levels from the highest and lowest. The problem of mathematical literacy ability level is divided into three groups, namely levels 1 and 2 as the lower scale, levels 3 and 4 including the medium scale, and levels 5 and 6 including the high scale. PISA content is divided into four main materials, namely, *quantity*, space and shape, *uncertainty and data*, and change and *relationship* (Setiawan &; Dores, 2019). PISA references in presenting problems using problems that contain context (Lutfianto &; Sari, 2017).

Table 1. Indonesia's PISA Ranking

Year	Literacy Assessment	Indonesia Average Score	Indonesia Ranking	Number of Participating Countries
2012	Mathematics	375	64	65
	Read	396	62	
	Science	382	64	
2015	Mathematics	386	63	69
	Read	397	61	
	Science	403	62	
2018	Mathematics	379	73	79
	Read	371	74	
	Science	396	71	

Source: Hewi & Shaleh, 2020

PISA problems emphasize students' ability to connect the context of the problem with mathematical concepts in order to obtain solutions from malasah (Rusmining, 2019). The results of the PISA study published by the OECD that assessed mathematical literacy skills showed in table 1.

Based on Table 1 that the mathematical literacy ability of Indonesian students from year to year has not improved significantly and is still in the low category. The condition occurs because students are not accustomed to doing questions related to the context of daily life. Through giving PISA questions regularly, students can practice understanding a problem quickly and use the basics of mathematics needed to solve problems in everyday life (Masjaya &; Wardono, 2018).Regarding in equipping students' mathematical literacy skills, teachers should provide opportunities for students to build their own knowledge and relate mathematics to life because through understanding concepts and the ability to apply concepts in everyday life problems become part of mathematical literacy competence (Susanti &; Syam, 2017). Related to mathematical literacy skills, according to Ahmad & Ni'mah (2019) stated that many students experience difficulties in the literacy process that applies mathematical concepts by 71.68%. The low ability of mathematical literacy is due to the quality of mathematics learning which is still relatively low.

Mathematics learning is not too emphasized aspects of knowledge and understanding, aspects of application, analysis, and evaluation so that students are less trained to hone their mathematical literacy skills (Martalyna et al, 2018). Kholifasari et al (2020) stated that the factor that affects the low ability of mathematical literacy is because students have difficulty understanding and planning strategies to solve problems so that they do not provide the right steps in solving problems. As for Wulandari &; Azka in (Habibi &; Suparman, 2020) stated that there are many determinants that affect students' mathematical literacy abilities, namely learning provided by teachers, classroom environment, family support, readiness in learning implementation and independent attitude in learning. Students' independent attitude in learning can be formed in a condition known as learning independence. Learning independence as one of the basic abilities needed by students in learning because it can increase student motivation in controlling behavior and using their cognitive to learn to beresponsible for the learning process and in overcoming various problems (Aryanti, 2020).

Basically, learning independence as behavior built by knowledge and competencies possessed by students who provide provisions for students in carrying out active learning activities that are driven by the intention or motive of mastering competencies to solve a problem (Huda et al., 2019). Independent learning skills need to be honed and familiarized in student activities, because learning independence becomes animportant actor that also determines learning success in learning mathematics. As one of the efforts to determine students' mathematical literacy skills, researchers examine students' mathematical literacy abilities in solving PISA problems, number content (*Quantity)* in terms of student learning independence. Johan (Rokhima et al, 2021) that the content of numbers becomes one of the most challenging and most essential mathematical content. This content deals with the relationship of numbers and number patterns including the ability to understand sizes, number patterns, and everything related to numbers in everyday life, such as counting and measuring certain objects. Operating numbers is an important aspect in learning mathematics because if students do not have a good understanding of number material, it affects the sub-material in other PISA contents.

2. METHOD

This research uses a qualitative approach with a descriptive method. The descriptive method is a research method carried out to get an overview of ongoing events or problems or events in the present with an effort to explain or describe the things that happen (Siti et

al, 2020). Researchers chose the descriptive research method because it was in accordance with the purpose of the study, which was to describe and see an overview of students' mathematical literacy abilities in solving PISA problems. This research was conducted in the even semester of FY. 2023/2024 with the subject of this study, SMPN 02 Siak Hulu class IX as many as 20 students. The subjects of the study were selected using *pusposive sampling techniques.* The instruments used were PISA *quantity* questions, learning independence questionnaires, and interview guidelines. The PISA question model, content *quantity* was adopted from Noviana & Budi's (2020) research which has met the valid category consisting of 6 questions.

Researchers took one student from each learning independence category as a sample who was analyzed and interviewed. The interview guidelines used are semi-structured. Theanalysis technique used in this study refers to data analysis techniques according to Miles and Hubersman which are carried out with steps, namely, data reduction, data exposure and conclusions. The activities that the researchers carried out were resistant to data reduction, namely: collecting data on students' mathematical literacy skills obtained and solving PISA questions and learning independence data from questionnaires, collectingthe results of mathematical literacy ability tests andquestionnaires and interviewing research subjects. The dataobtained are neatly arranged and grouped into three categories, including learning independence in the high, medium, and low categories.

Furthermore, the data presentation stage, namely presentingthe data that has been obtained from the PISA question test results and presenting the answer sheet into descriptive form, tables, and pictures about student abilities in accordance with learning independence. The following indicators of mathematical literacy ability arepresented in table 2:

Table 2. Indicators of Students Mathematical Literacy Ability

Level	Indicators
1	Identify aspects in mathematics of real-context situations
2	Identify situations for categories that require immediate resolution
3	Implement and resolve issues using procedures
4	Identify information from the problem that involves context assumptions
5	Implement strategies based on modeling on complex situations
6	Interpret and reflect on the results of work based on the model

Source: (OCED, 2016)

3. RESULTS AND DISCUSSION

3.1 RESULT

This study obtained data on the results of filling out student learning independence questionnaires and PISA test results. Based on the results of the student learning questionnaire analysis, there are 3 criteria grouped, namely students with high, medium, and low learning independence. The following is the number of students who have been grouped based on the criteria of learning independence:

Table 3. Group Learning Independence Questionnaire Results

Categories Learning Independence	Number of Students
High	2
Medium	15
Low	3

Based on the acquisition of Table 3 shows that students have different levels of learning independence, including 2 students with high learning independence, students for the medium learning independence category and 15 low learning independence category there are 3 students. After knowing the learning independence of 20 students, the researcher continued by taking 3 students where 1 subject represented the category of learning independence to examine their mathematical literacy skills in doing PISA problems.

Table 4. List of Research Subjects

Subject Initials	Categories Learning Independence	PISA Test Scores
RSD	High	51
NAA	Medium	43
RS	Low	31

Research subjects grouped by learning independence category were analyzed based on indicators of mathematical literacy.

3.2 DISCUSSION

Level 1 Question

A chef is preparing salad dressing dough for a wedding. Here is a recipe for making 150 milliliters (mL) of salad dressing dough:

Material	Dosage
Oil Salad	90 mL
Vinegar	45 mL
Soy Sauce	15 mL

If the chef wants to make mL of salad dressing, determine how much each ingredient does? 500 (PISA level: 1, *context: personal, process: formulate*)

The number of students who can do question number 1 correctly is 8 students. Students with high learning independence are RSD subjects withthe score of question number 1 is 8 out of 10. Based on the score, grades and answer sheets, RSD subjects can understand and identify the information contained in the questions by writing them correctly. Students with moderate learning independence were NAA subjects earning a sscore of 5 out of 10. Based on the score and answer sheet, the NAA subject showed that it was able to identify the information contained in the question but was not accurate in writing back the information into the solution. Students with low learning independence were RS subjects obtaining a score of 3 out of 10. Based on the grade score and answer sheet, the RS subject shows that students are able to take the information contained in the question but there are still errors in writing back into the solution.

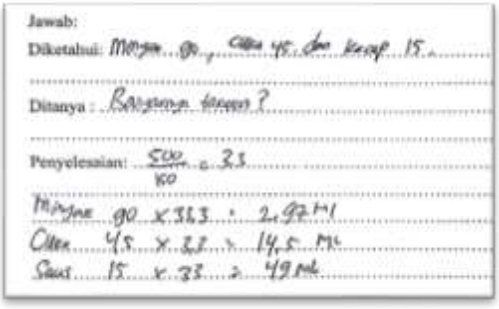


Figure 1. RS Answer to Question Number 1

Figure 1 shows that students have not been able to identify complete information on the question as it is known and asked in the question there is still something that has not been written. Based on the results of the work of hospital students, it indicates that they are not careful in reading the questions so that there are parts of information that have not been written. The subject of the RS hastened in writing down the settlement as a result of misstating the known information again. Based on this presentation, it shows that hospital students can identify the information contained in the question but still cannot understand the meaning of the question so that there are still errors in solving it.

Level 2 Question

John works at a shop that rents DVDs and computer games. In this store there is a fee to become a permanent member for zeds which is valid for a year. DVD rental fees are cheaper than non-member rental fees 10 , asshown in the following table:

Non-member rental fee for one DVD	Member rental fee for one DVD
4,20zeds	3,50zeds

Last year Hary was a member of a DVD rental store. Last year Hary spent zeds including his membership fee. How much would it cost Harry a total if he wasn't a member, but Harry had rented the same amount of DVDs? 64,50 (PISA level:2, *context: personal, process:formulate*)

Many students have difficulty in doing question number 2 so that no student answers correctly. Students with high learning independence are RSD subjects on question number 2 obtaining a score of 3 out of 10. Based on grade scores and answer sheets, RSD subjects show that students have not been able to know the situation for categories that require solving problems directly. Students with moderate learning independence are NAA subjects obtaining a score of 3 out of 10. Based on grade scores and subject answer sheets, NAA indicates students cannot recognize situations for categories that require immediate completion. Students with low learning independence scored 3 out of 10. Based on the grade scores and answer sheets, the RS subjects showed that students were unable toknow the situation for the category thatneeded immediate completion.

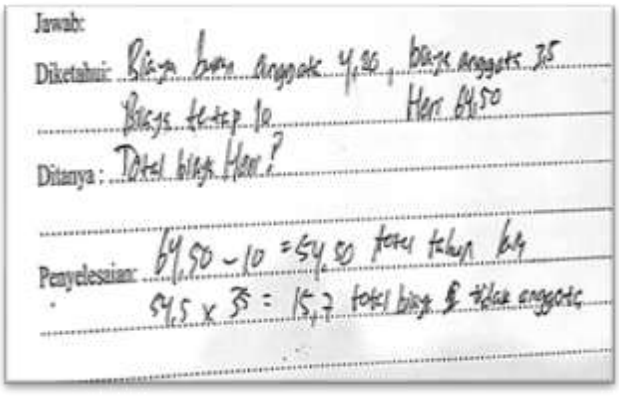


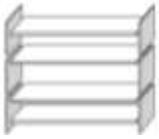
Figure 2. RS answer to question number 2

Figure 2 shows that hospital students have not been able to recognize the problem contained in the problem seen in the inaccuracy in choosing relevant information to solve the problem. Based on the work of the hospital students, the part asked was the total cost spent by Harry as a member, in fact, the question asked for the total cost of Harry if he did not become a member by renting the same number of DVDs. RS students admitted that they

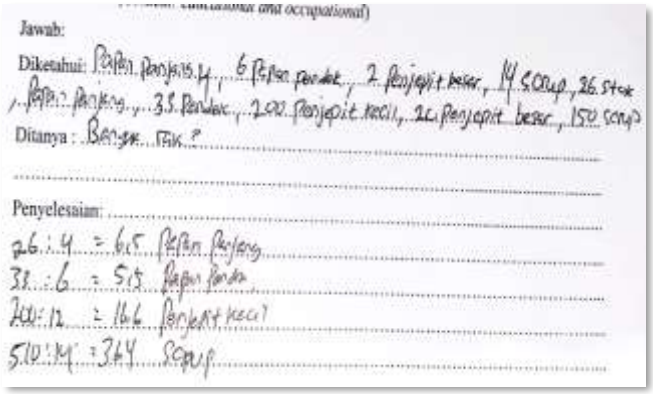
did not read the whole question because they were stuck in time so they did not understand the meaning of the question well. RS students are not detailed in writing down the solution, it seems that they do not make a solution formula and make a final conclusion. Based on this presentation, it shows that hospital students cannot recognize the problems contained in the questions.

Level 3 Question

To make a bookcase, a craftsman needs materials, namely, long wooden plank fruit, short wooden board fruit, small tongs, large tongs and screw fruits. The craftsman keeps a stock of long wooden boards, short wooden planks, small tongs, large tongs and screw fruits. How many bookshelves can a craftsman possibly make? (Level PISA: 3, *context: educational and occupational*)



The number of students who can do question number 3 correctly is 3 students. Students with high learning independence are RSD subjects on question number 3 obtained a score of 10 out of 15. Based on grade scores and answer sheets, RSD subjects show that students are able touse mathematical concepts according to algorithms. Students with moderate learning independence were NAA subjects obtaining a score of 10 out of 15. Based on grade scores and answer sheets, NAA subjects show students are able to solve mathematical concept problems according to algorithms, however, there are errors in writing the final results. While students with low learning independence were RS subjects with ascore of 10 out of 15. Based on the score and answer sheet, the RS subject shows that students are able to use mathematical concepts according to the algorithm, but in solving there are still errors in writing the final answer so that the value is not right.


Jawab:

Diketahui: Papan Panjang 4, 6 Papan pendek, 2 Penjepit besar, 14 Soup, 26 Stok, Papan Panjang, 35 Pendek, 200 Penjepit kecil, 24 Penjepit besar, 150 Soup

Ditanya: Berapa Rak ?

Penyelesaian:

26 : 4 = 6,5 Papan Panjang

32 : 6 = 5,3 Papan Pendek

200 : 12 = 16,6 Penjepit kecil

510 : 14 = 36,4 Soup

Figure 3. RS Answer Question Number 3

Figure 3 above shows that students can already use the scoring operation according to the algorithm but are incomplete in writing the answer to the solution. RS students lack detail in writing down the elements contained in the problem and are incomplete in describing the answer to the solution such as the number of shelves for small tongs is not written. Based on the presentation, it shows that students can solve problems using mathematical concepts according to the algorithm but there are still errors in writing the final answer.

Level 4 Question

A pizzeria offers pizza with two basic toppings: cheese and tomato. Customers can also order pizza with extra toppings. There are four choices for extratoppings, namely meat, mushrooms, salami, and olives. Bela wanted to order a pizza with two kinds of toppings rattling. How many topping combinations can Bella order? (PISA level: 4, *context: educational and occupational*)

The number of students who can do question number 4 well is only 1 student. Students with high learning independence are RSD subjects obtaining a score on question number 4 of 12 out of 15. Based on the score, grades and answer sheets, it shows that students can write down the elements contained in the problem and relate the elements to the problem solving. This indicates that the RSD subject has been able to identify the information contained in the problem that involves context assumptions. Students with moderate learning independence were NAA subjects obtaining a score of 8 out of 15. Based on scores, grades and answer sheets, NAA subjects have been able to write down the elements contained in the question but have not been able to relate these elements to problem solving. This suggests that NAA subjects are still unable to involve context assumptions in the settlement.

Thosewith low learning independence were RS subjects who scored 5 out of 15. Based on the score, grades and answer sheet, the RS subject has been able to write down the elements on the question but has not been able to relate them to the problem solving. This shows that the subject of NAA is still unable to engage context assumptions so that the answers are wrong.

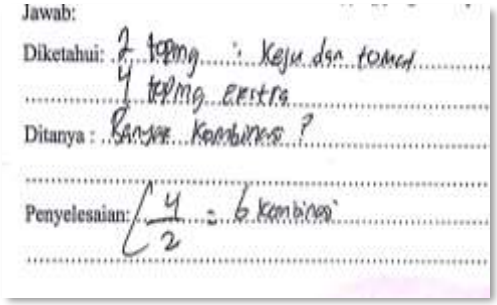


Figure 4. RS Answer Question Number 4

Figure 4 above shows that the RS subject has been able to recognize known information but has not been able to understand the meaning of the question looks inaccurate in determining what is asked in the question. RS subjects are still not optimal in doing the problem, look not detailed in describing the solving steps and wrong in writing symbols from combinations. Based on the presentation of the answers, students showed that they could not yet relate known elements to the solution.

Level 5 Question

A cheese factory in Bandung can produce cheese every day as shown in the table with a fixed pattern in the day. Mr. Abas as an employee of the cheese factory who is in charge of inspecting damage to cheese products. What was the amount of production and a lot of damage that Mr. Abas found on the day?1010(Level PISA: 5, *context: occupation*)

Day To	Production Quantity	Lots of Damage
1	1500	30
2	1400	28
3	1550	31

4	1500	30
5	1600	32
6	1600	32

Many students have difficulty in doing question number 5 so no one manages to solve it correctly. Students with high learning independence are RSD subjects getting a score of 10 out of 25. Based on scores, grades and answer sheets, RSD subjects show that students can design strategies to solve problems, but are less careful in doing calculations, so they are still not precise in applying strategies based on modeling to complex situations. Thosewith moderate learning independence were NAA subjects obtaining a score of 10 out of 25. Based on grade scores and answer sheets, NAA subjects show students are less precise in choosing strategies to solve problems so that the solution is wrong. This indicates that NAA subjects have not been able to apply strategies based on modeling to complex situations. Meanwhile, studentswith low learning independence obtained a score of 4 out of 25. Based on the score and answer sheet, the RS subject shows that students are not right in choosing strategies to solve the problem so that the solution is wrong. This indicates that NAA subjects have not been able to apply strategies based on modeling to complex situations.

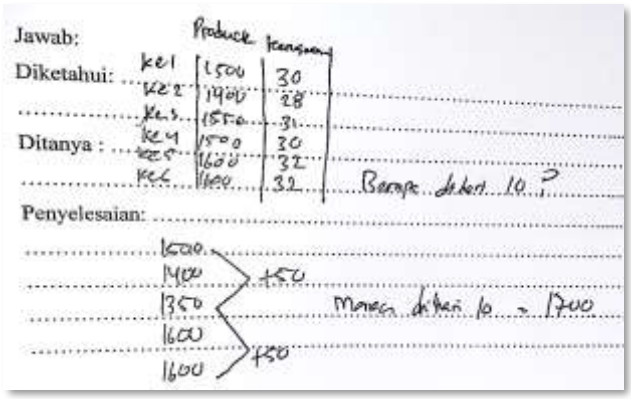


Figure 5. RS Answer Question Number 5

Based on Figure 5 shows that students have been able to design strategies, namely by using number patterns to solve the above problems but there are errors in doing calculations. The RS subject was correct in choosing a strategy using a number pattern, but the pattern formed by students in the form of determining the amount of production in day-10 was still not right because students were incomplete in writing down the number sequence so that the wrong solving results were obtained. The subject of RS is also in writing the solution is still less detailed so that there are parts that are not elaborated. The RS subject did not write down the calculation process directly making conclusions so as to confuse 1700 and 36 obtained from where. Based on this presentation, it shows that RS subjects can design strategies but are not precise in the calculation process$+50$.

Level 6 Question

Here is a picture of Javanese batik motifs.

A fabric with a wide area 6 cm^2painted white flower fruit consisting of petals14. Then, for fabrics with area 12 cm^2 Painted white flower fruit consisting of 4 petals and so 16 on. Suppose is the number of rows of white flowers then n^2 as the number of flowers is white and is a broad fabric. If the fabric used is wider with the same white floral motif as the previous pattern, which one increases faster. Number of white flowers or area of fabric? Prove and explain your answer! (PISA Level: 6, *context: occupation*)

Many students have difficulty in doing question number 6 so no one manages to solve it correctly. Students with high learning independence are RSD subjects obtaining a score of 3 out of 25. Based on the score and answer sheet, the RSD subject shows that students can understand the model of the question, but there are still errors in using their reasoning for problem solving so that the conclusions on the questions given are still incorrect. This indicates that the RSD subject has not been able to interpret and reflect on the results of work based on the model. Then, for students with moderate learning independence, NAA subjects scored 2 out of 25. Based on the score and answer sheet, NAA subjects do not understand the model of the questions so they have difficulty in solving the problem. This shows that NAA subjects cannot interpret and reflect on the results of work based on models. While students with low learning independence were RS subjects scored 3 out of 25. Based on the score and answer sheet, the RS subject showed that they were not able to understand the meaning of the question so that it was not optimal in solving the question.

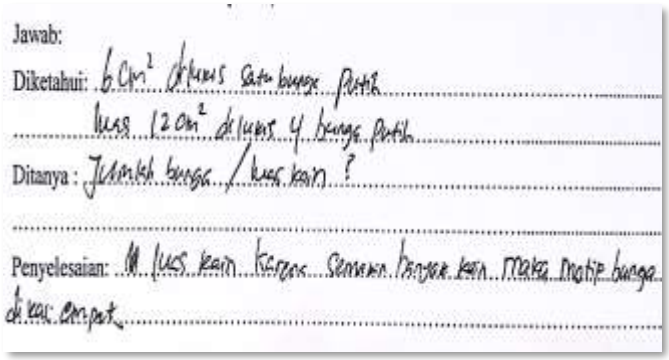


Figure 6. RS Answer Question Number 6

Based on Figure 6, it shows that students cannot understand what is asked in the question and in using their reasoning to solve the problem, the problem is still not appropriate so that it is not optimal in making final conclusions. The RS subject in solving the problem immediately concluded that the fabric area increased faster, without giving exposure to the calculation process of the final answer. Based on the explanation that RSD subjects cannot interpret and reflect on the results of work based on the model.

Based on the data obtained, most students are not optimal in solving level 2, 4, 5, and 6 questions, the reason is that they do not understand the meaning of the questions well because they do not read the questions thoroughly and limited processing time. The results of interviews with students with high category learning independence, namely RSD subjects experience difficulties and obstacles in doing PISA questions because they have never done these questions so that students feel foreign. RSD subjects also experience confusion in using the right mathematical concepts for each problem. Then for students of moderate learning independence, namely NAA subjects have difficulty in solving PISA questions because the questions given are long and difficult to understand. NAA subjects still have difficulty in choosing a solution strategy because they feel confused about which mathematical formula to use to solve the problem. NAA subjects find it difficult to do because the form of the problem has never been studied before.

As for students with low learning independence, namely the subject of RS experiencing problems in working because the questions in the form of long stories will be difficult to understand so that they do not understand the meaning of what is asked in the questions. Limited processing time makes the RS subject rush to do the problem, making him less careful to do calculations and write down the information contained in the problem. The RS subject claimed not to remember the formula so he was confused about determining the mathematical concepts used to solve the problem. The results obtained by the researchers are in line with the research of Sujadi et al. (2022) states that students' lack of understanding of the problem is because they are not used to doing math practice problems with PISA characteristics and do not know mathematical concepts make students experience confusion in solving problems. According to Mutia et al, (2021) teachers more often give rut in questions compared to non-routine questions to students so that students are not trained in solving non-routine problems such as those found in PISA. Because there are still many students who are not familiar with doing and understanding PISA characteristic questions, teachers are expected to include discussions about the PIS A model in thelearning process.

Through the provision of practice questions or tasks that are acteristic, PISA can help students to improve their mathematical literacy skills (Madensi et al, 2020). In line with research conducted by Susanti & Syam (2017) that teachers play a role in improving students' mathematical literacy skills. One of the efforts so that students have good mathematical literacy skills is to challenge students in solving more PISA-based math problems so as to force students to obtain mathematical information from real-world problems. It tries to help provide opportunities for students to engage in real-world problems aimed at making maths more interesting and relevant to students and can develop broader mathematical competencies. Efforts to improve students' mathematical literacy skills are the need for changes in learning design that can support the achievement of mathematical literacy indicators. In this regard, it is necessary to pay more attention to teachers developing students' mathematical literacy skills. Seeing mathematical literacy skills is one of the abilities needed by students to answer PISA questions.

4. CONCLUSION

Based on the presentation and discussion of the study results, the ability of student learning independence varies with the high category learning independence of as many as two students. For the medium category, as many as three students with low categories. Students with high learning independence can identify aspects in mathematics of real context situations, implement and solve problems using procedures, identify information from problems that involve context assumptions and are not yet able to recognize situations for categories that require direct solutions, implement strategies based on modelling complex situations and interpret and reflect on the results of work model-driven. Students with moderate learning independence can identify aspects in mathematics of real context situations and implement and solve problems using procedures and are not yet able to recognize situations for categories that require direct resolution, identify information from problems involving context assumptions, implement strategies based on modelling complex situations and interpret and reflect on results Model-driven artistry.

Students with low learning independence are not yet able to identify aspects in mathematics of real-context situations, recognize situations for categories that require direct resolution, implement and solve problems using procedures, identify information from problems involving context assumptions, implement strategies based on modelling complex situations and interpret and reflect on the results of work based on models. This condition is caused because students are not used to being faced with questions that refer to the PISA model. Students' low mathematical literacy ability is caused by not understanding the

concepts in the material contained in the problem. They need help understanding the meaning of the problem, are confused about determining the mathematical concepts used, and cannot apply solving strategies.

5. SUGGESTION

It is expected that teachers can train students by providing PISA model questions as a step to develop students' mathematical skills so that students can utilize mathematical literacy skills in solving various problems of daily life and be better prepared to do PISA problems. There are suggestions to other researchers who will conduct similar studies to examine mathematical literacy skills at the high school level and above on all PISA content.

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LITERACY AND NUMERACY SKILLS OF STUDENTS SD NEGERI BENER PEKALONGAN REGENCY BASED ON AKM IN 2021

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ABSTRACT

In 2021, the UN was abolished and then replaced with AKM. AKM aims to enable students to develop and actively participate in community life, including reading and mathematical literacy (numeracy). This research describes the literacy and numeracy skills of grade V students of SD Negeri Bener based on the results of an assessment-based minimum competency assessment. This research uses qualitative methods. The research subjects used were the principal, class V teachers, grade V students, and the GLS Program Team of SD Negeri Bener, Wiradesa District, Pekalongan Regency, consisting of 8 people—data collection using in-depth interviews, observation, and documentation. The instruments of this study are recording devices and photo documentation. Data validity using triangulation and data analysis using interactive analysis models. Based on data analysis, it was found that students' literacy abilities based on the evaluation results in the AKM in November 2021 of 1.83 were included in the proficient category, which means that most students reached the minimum level of competence in literacy skills; this is evidenced that most grade V students can interpret indirect information in the text and can draw conclusions from the text, As for students' numeracy ability of 1.63, included in the low category which means less than 50% of students achieve a minimum level of competence and less than 50% of students who can know, apply, count, and understand the concept of number domains; algebraic domains; geometry domain; Data and uncertainty domains.

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1. INTRODUCTION

In 2021 UN was abolished then replaced with AKM. AKM aims to make students able to develop and actively participate in community life, including in reading literacy and mathematical literacy (numeracy). In improving this ability, the principal of SD Negeri Bener implemented the GLS held by the Ministry of Education and Culture.

Kemendikbud (2020) said The GLS program is a program that aims to develop student character by cultivating reading and writing, students can expand their skills in reading and writing which then these skills are measured using an assessment system based on AKM. AKM is designed to measure depth of expertise, not just mastery of content. AKM competencies are divided into qualitative literacy and mathematical literacy (numeracy) (Kemendikbud, 2020).

The results of the Program for International Student Assessment (PISA) 2018 revealed that Indonesia's average score was 371 points lower than the average of 487 points of OECD countries. 15-year-olds scored an average score of 379 in math, compared with an average score of 489 points in other countries. On reading skills among able and underprivileged students in Indonesia is 52 points, compared to an average score of 89 points in other countries. Based on the results of PISA 2018, it can be concluded that the literacy and numeracy level of Indonesian people is still relatively low compared to other countries.

Based on Aswita research (2022), it can be concluded that Literacy includes reading and writing, integrating or listening, speaking, reading, writing and thinking, mastering new ideas, supporting success in academic and social environments, speaking, reading and taking notes are definitely needed, and the ability of one scholar to understand discourse professionally (Aswita, 2022).

The Literacy skills of elementary school students need to be optimized because reading and writing skills in elementary school students are included in the deficient category. The test results conducted by the Indonesian National Assessment Program (INAP) show that literacy, scientific literacy, and mathematical literacy are still weak.

Based on Ekowati and Suwandayani research (2019), it can be concluded that Students' mathematical literacy ability is relatively low, this is because mathematics learning is considered less important and still not contextual for students, making it difficult for students to understand visual representations and models when building mathematical concepts.

Based on Maharani research (2022), it can be concluded that only some grade V students of SD Negeri Lubang Buaya 08 Pagi participated in AKM. The method used by students to prepare AKM literacy questions is through easy preparation of questions at the beginning, while the results of Putri's research (2022) explain that SD Negeri Taji is successful in holding AKM, as evidenced by the implementation of AKM running well, feasible for all grade V students in online mode 2 for 2 day sessions, but in terms of arithmetic it is explained that the majority of students have not reached the minimum level (Maharani & Wahidin, 2022).

Previous research related to AKM is found in the research of Rohim *et al.,* (2021) entitled "The Concept of Minimum Competency Assessment to Improve Elementary School Students' Numeracy Literacy Skills" which uses research subjects in the form of fifth grade students in elementary schools with the type of research is a literature study. Another study conducted by Patriani *et al*., (2021) entitled "Acculturating Numeracy Literacy for Minimum Competency Assessment in Curricular Activities at Muhammadiyah Elementary Schools" The subjects of this study were teachers, principals, and fifth grade students from Muhammadiyah Elementary Schools in Surakarta. Research conducted by Mahardhani *et al*., (2021) entitled "Empowering Elementary Students in Reading Literacy through Picture Media in Magetan". The subjects of this study were children in the neighborhood of Dukuh Jiwir RT 02 / RW 01 elementary school level grade I and grade II. The method used in the research is the method of implementing community service KKN activities carried out through several stages. However, although there has been research related to AKM, there has been no research related to AKM at Bener Pekalongan State Elementary School using interviews and documentation methods. Therefore, research was conducted related to

improving AKM-based literacy and numeracy skills in grade V students of SD Negeri Bener Pekalongan (Mahardhani *et al.*, 2021; Patriana *et al*., 2021; Rohim *et al*., 2021).

AKM is an assessment of basic skills divided into qualitative literacy and mathematical literacy (numeraasi) needed by students so that students can expand their skills and actively participate in social activities. AKM aims to measure the depth of expertise, not just mastery of content (Kemendikbud, 2020).

Literasi skills at SD Negeri Bener are included in the good category, but for numeracy skills at SD Negeri Bener it is included in the low category, therefore this study was made with the aim to explain the implementation of the GLS program that can improve the literacy and numeracy skills of students of SD Negeri Bener based on AKM; describe the literacy and numeracy skills of students of SD Negeri Bener based on AKM; and describe the supporting and inhibiting factors of literacy and numeracy skills of students SD Negeri Bener.

2. METHOD

The research method is to use a descriptive design, because this study aims to describe the literacy and numeracy skills of students SD Negeri Bener based on the results of the assessment on AKM. The research was conducted at SD Negeri Bener, Pekalongan Regency. The research subjects used were class V teachers, GLS Team and class V students as many as 35 students consisting of 30 main students, and 5 reserve students used for AKM assessment. The object of research used is in the form of improving literacy and numeracy skills based on Minimum Competency Assessment through the GLS Program.

The research instrument uses in-depth interview guidelines (indept interview), the results of student literacy and numeracy ability assessments, documentation of the implementation of the GLS program. Data obtained the results of student literacy and numeracy ability assessments, documentation of the implementation of the GLS program. Observation instruments are analyzed by qualitative approach, interview instruments are analyzed by means of qualitative approach and documentation instruments in analysts by means of qualitative approach. Data analysis used in the form of interactive models, namely data collection, data reduction, and conclusions.

Table 1. Result Of the AKM-Based National Assessment at SD Negeri Bener in 2021

Education Unit	Literacy	Numeracy
SD Negeri Bener	1,83	1,63
Pekalongan Regency	1,77	1,60
Central Java Province	1,81	1,62
National	1,79	1,61
National Average	1,71	1,57

2.1 Category Literacy Level

2.1.1 Value Range 2.10 – 3.00 Advanced Category

Literacy student at schools showed the level of reading literacy proficiently; quite a lot of students are at an advanced level; students are able to integrate multiple cross-text information; evaluate the content, quality, way of writing the text; and be reflective of the content of the text. Student The Results should include the rationale or design of the experiments as well as the results of the experiments. Results can be presented in figures,

tables, and text. The Results should include the rationale or design of the experiments as well as the results of the experiments. Results can be presented in figures, tables, and text. Numeracy students at schools showed the level of proficient category; students are able to reason to solve complex problems that exist in mathematical concepts.

2.1.2 Value Range 1.80 – 2.09 Cakap Category

Most students have reached the minimum competency literacy skill, however it takes more effort to encourage students to become proficient; student able to make interpretations of implicit information in the text; can make inferences from some information in a text; students are able to integrate multiple cross-text information; evaluate the content, quality, way of writing the text; and be reflective of the content of the text. Student The Results should include the rationale or design of the experiments as well as the results of the experiments. Results can be presented in figures, tables, and text. The Results should include the rationale or design of the experiments as well as the results of the experiments. Results can be presented in figures, tables, and text. Most students have reached the minimum competency numeracy skill, however it takes more effort to encourage students to become proficient; students able to apply mathematical knowledge possessed in more diverse contexts.

2.1.3 Value Range 1.40 – 1.79 Basic Category

Less than 50% of students have achieved minimum competency for literacy reading, students able to find and retrieve information explicit in the text as well as making interpretation simple. Less than 50% of students have achieved minimum competency for numeracy; Students have basic mathematical skills; Computing Basic in the form of direct equations, basic concepts related to geography and statistics; as well as solving simple math problems.

2.1.4 Value Range 1.00 – 1.39 Categories Need Special Intervention

Most students have not reached the minimum competency for literacy is limit; students have not been able to find and retrieve explicit information in the text or make simple interpretations. Most students have not reached the minimum competency for numeracy is limit. Students have only limited mathematical knowledge.

3. RESULTS AND DISCUSSION

3.1. Result

Based on data analysis, it was found that students' literacy abilities based on the results of the evaluation in the AKM in November 2021 of 1.83 were included in the proficient cakap category, which means that most students reached a minimum level of competence in literacy skills, this is evidenced that most grade V students can interpret indirect information in the text and can draw conclusions from the text, While for student numeracy ability of 1.63, included in the low category. It is in accordance with the classification of that Pusmenjar 2020 that numeracy in range 1.40 – 1.79 include in Basic Category (Pusmenjar, 2020).

Based on the results of the data obtained, where the numeracy score of 1.63 and the literacy value of 1.83 shows that students are included in the category of literate proficiency and include the basic classification in the basic category of numeracy. Which means less than 50% of students achieve a minimum level of competence in numeracy ability. Students have basic mathematical skills; Computing Basic in the form of direct equations, basic concepts related to geography and statistics; as well as solving simple math problems and it is proven that less than 50% of students have the ability to know, apply, reason in the numeracy skill.

3.2. Discussion

The implementation of the GLS Program held at SD Negeri Bener, Wiradesa District, Pekalongan Regency can be carried out well. Based on the results of the assessment on AKM, it was obtained that students' literacy skills in November 2021 obtained results of 1.83 included in the proficient category, meaning that most grade V students reached a minimum level of competence in literacy skills, this is evidenced that most grade V students can interpret indirect information in the text and can draw conclusions from the text, while for students' numeracy ability, results of 1.63 were included in the low category, meaning that less than 50% of grade V students reached the minimum level of competence in numeracy ability, it is proven that less than 50% of grade V students have the ability to know, apply, reason in the number domain; algebraic domain; geometry domain; data and uncertainty domains.

Hayun and Haryati (2020) states that the implementation of the Indonesian literacy movement program has a fundamental role in the linguistic intelligence of students at the elementary, junior high, high school, and tertiary levels. The purpose of this GLS Program is so that students are accustomed to reading and motivated to write, thereby increasing students' potential in making written works such as short stories, serials, poems, and making simple articles (Hayun & Haryati, 2020).

The implementation of the GLS Program is expected to foster interest and reading culture in students. The development of digital information technology causes students to be lazy to read reading books, both physical reading books and digital reading books. Therefore, the implementation of the GLS program in basic students is expected to foster students' interest and reading culture. Kamardana (2021) states that there is an effectiveness of the implementation of the GLS program on students' reading interest and learning outcomes (Kamardana *et al.*, 2021).

GLS programs are not always successful or workable in every school. Jannah (2021) stated that the implementation of the GLS program at SD Negeri Gading Kulon II at the learning stage has not been carried out optimally, therefore SD Negeri Gading Kulon II needs to carry out Literacy Activation which includes basic literacy, media literacy, technology, library and visual (Jannah *et al.*, 2022).

Setiani (2022) stated that there are internal and external factors that affect students' literacy skills. External factors in the form of student reading culture are still low, the implementation of literacy programs that cannot be carried out optimally, the available reading slogans are still lacking and the content of mading is rarely updated, the role of the library has not been maximized such as the condition of the library is not well maintained; library services are less than optimal; library layout that looks less neat; lack of facilities in providing knowledge books and reading books, The learning applied by teachers in class is still dominant in doing problems, when at home, students only play with friends and play cellphones because students do not have a collection of knowledge books and reading books at home (Setiani, 2022).

Research conducted at SD Negeri Bener Wiradesa District found that in the implementation of the GLS program, facilities and infrastructure in schools are good such as the availability of books, reading gazebos, reading corners, information walls, libraries, canteens and school environments, displaying student work, besides that the school also formed a GLS Team. This is included in the input from the GLS program at SD Negeri Bener, Wiradesa District, Pekalongan Regency. Syah & Nugroho (2022) who said that efforts to simulate reading culture for 15 minutes before learning and create a reading corner

from student work, have succeeded in fostering student reading culture (Syah & Nugroho, 2022).

Facilities and infrastructure in the implementation of the AKM-based GLS program are factors that play an important role in the success of program implementation, but there are facilities that have not been fulfilled, namely modules issued by the Ministry of Education and Culture, Directorate General of PAUD, Basic Education, Secondary Education, Jakarta 2021, while these modules are guidelines or benchmarks for GLS program implementation (Kemendikbud, 2020).

The school library is a facility that provides books to support literacy activities and is a facility that has an important role in improving student literacy. A varied and interesting collection of books can support these activities. Muali and Rohman (2023) mentioned that efforts to develop aspects of student literacy by means of library programs, book collections, systems and management of implementation and library infrastructure (Muali & Rohman, 2023).

The GLS program at SD Negeri Bener, Wiradesa District, Pekalongan Regency has been carried out since 2014, but AKM activities were only carried out in 2021. The implementation of GLS Program Activities carried out is in accordance with the policy of the Minister of Education and Culture Number 23 of 2015 concerning the Procurement of School Literacy Movements and Infrastructure Facilities. This policy is used as a formal juridical basis for the implementation of GLS programs in schools, especially at the elementary school level. According to Nurfadillah & Zulfika (2020) the implementation of the GLS program in MI/ SD is implemented in accordance with the regulation of the Minister of Education and Culture Number 23 of 2015 concerning the growth of ethics which is applied daily, weekly, monthly and per semester (Nurfadillah & Zulfika, 2020).

The implementation of the GLS program at SD Negeri Bener, Wiradesa District, Pekalongan Regency is carried out in 3 stages, namely Stage 1 in the form of Habituation Stage, Stage 2 in the form of Development Stage, Stage 3 in the form of Learning Stage.

Stage 1 is the habituation stage. The GLS program at the habituation stage at SD Negeri Bener conducts non-lesson book reading activities before learning starts for 15 minutes. The purpose of this habituation stage is to foster interest in reading, familiarize students in literacy, and improve students' skills in reading, listening, writing and speaking. Purwadi (2019) stated that the 15-minute book reading activity was carried out in the morning at SD Negeri Pangkalpinang (Purwadi *et al.*, 2019).

Stage 2 is the development stage. The GLS program at the development stage at SD Negeri Bener has been running well, starting with the formation of the GLS Team, preparing a work plan, creating a reading corner, reading gazebo and utilizing the school library. This development stage aims to determine achievements during the implementation of the GLS program, describe students' literacy and numeracy skills, as well as supporting and inhibiting factors that occur during the GLS program. Triaryanti & Hidayah (2018) stated that the GLS program at this development stage through (1) Planning Stage, where the school creates a GLS Team to prepare an Annual Work Plan, (2) Implementation Stage, namely making reading corners, selecting reading books, habituating reading and writing, library utilization, student appreciation, creating a text-rich environment, literacy competitions, and public engagement, (3) Evaluation Stage, namely achievement, supporting and inhibiting factors, and sustainability of literacy programs (Triaryanti & Hidayah, 2019).

Stage 3 is the learning stage. The GLS program at this learning stage has not been able to run optimally because the learning applied by teachers in the classroom is still dominant in doing questions and teachers rarely use school library facilities as a learning method.

The success of the GLS program requires the support of students, teachers and the family environment. Based on the results of the study, it is known that 50% of students do not have reading books at home and there is a lack of coordination between teachers and parents. Schools need to improve library services both manually and digitally, as well as reactivate parent groups or groups to provide support in the implementation of GLS activities. This is in accordance with Maharani's research (2022) stating that most grade V students of SDN Lubang Buaya 08 am who take part in AKM are still categorized as basic. This is because reading literacy skills are influenced by internal factors, namely student interest and external factors, namely family and school (Maharani & Wahidin, 2022).

Kartisari (2022) stated that the supporting factor of the GLS program is the commitment of the principal, the role of teachers, students and parents; Availability of sufficient funds for knowledge book facilities and reading books as well as funds for library services and library layout. The inhibiting factors of the GLS program are the role of libraries that have not been maximized; students' reading interest is still low; lack of parental involvement in GLS program activities (Kartikasari, 2022).

The implementation of the GLS program at SD Negeri Bener, Wiradesa District, Pekalongan Regency has involved parents since the early stages. Parents have an important role in providing full support to students in providing reading books and knowledge books, motivating, supervising, and increasing students' interest in reading. The ability of students in literacy and numeracy based on the results of AKM conducted in November 2021 at SD Negeri Bener found that the results for literacy were 1.83. This means that most grade V students of SD Negeri Bener have reached the minimum competency limit for literacy, and the numeracy ability result is 1.63. That is, less than 50% of students have reached the minimum competency limit. According to the Ministry of Education and Culture (2020), AKM is a fundamental competency assessment consisting of reading literacy and mathematical literacy (numeracy) which are needed by students, with the aim that students can develop their capacities and actively participate in society (Kemendikbud, 2020).

Indicators on reading literacy competence include competence in reading literary texts, students can get entertainment, enjoy stories, and do contemplation to live the life problems offered by the author or reader in the story; Competency in reading informational texts, namely students can access and find the content of the text, interpret and understand the content of the text, evaluate and reflect on the content of the text, obtain facts, data, and information which can later be developed as the development of scientific insight and science; Personal context competence aims to enable students to focus on the activities of a person, his or her family, or group; Competence in socio-cultural and scientific contexts aims to make students get things related to community problems or communities that are local, regional, national and global.

Abdoeloh (2023) stated that the AKM concept with the context of Numeration Literacy contains several contents, namely Numbers, Measurement and Geometry, Data and Uncertainty, and Algebra. In each indicator contains several cognitive processes such as understanding, application, and reasoning. Then in the context described in the form of personal, socio-cultural, and scientific (Abdoeloh & Suryana, 2023).

Indicators on numeracy competence have context, namely personal context, socio-cultural context and scientific context. The personal context focuses on the activities of students, individuals, families, and groups. In the socio-cultural context related to community or community problems, be it local, regional, national, or global. In the scientific

context related to the application of mathematics in the form of *understanding*, *applying*, and reasoning.

Based on the results of tests, observations and interviews that have been presented in the AKM-based National Assessment results table on Literacy and Numeracy, it is concluded that the average student in literacy ability has a moderate level of ability, meaning that students have the ability to find and retrieve explicit information contained in the text and make simple interpretations and the average student in numeracy ability has a low level of ability, this means that less than 50% of students have not been able to understand the concepts of knowing, applying, reasoning in Number Domains; Algebraic domains; Geometry Domain; Data and Uncertainty Domains.

4. CONCLUSION

SD Negeri Bener has implemented a comprehensive approach to enhance literacy and numeracy skills, employing various initiatives like the GLS program, reading spaces, involvement of parents, and extensive resource provision. However, challenges persist, including coordination issues with parents and limited access to reading materials at home. The impact of the GLS program on literacy is significant, evident in students' enhanced reading habits and writing skills. Nevertheless, numeracy skills remain a concern, with a significant portion of students falling below the minimum competency level. The school is actively addressing obstacles to improve both literacy and numeracy skills through lending library books and digital activation. The proficiency evaluation in literacy indicates commendable performance, yet numeracy skills require more attention. Further research is recommended to delve deeper into methods, incorporating qualitative and quantitative approaches, aiming to bolster parental involvement and optimize literacy and numeracy programs at SD Negeri Bener.

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PROFILE OF STUDENTS' METACOGNITIVE SKILLS IN SOLVING MATHEMATICAL PROBLEMS OF SMPN 3 PALU IN VIEW OF MATHEMATICAL ABILITY

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ABSTRACT

Understanding students' metacognitive skills in solving math problems concerning their mathematical abilities is crucial for identifying the cognitive processes involved in problem-solving. This study investigates the metacognitive skills of SMPN 3 Palu students with varying mathematical abilities in problem-solving. It focuses on students in class VIIJ during the 2022/2023 academic year, individually analyzing one high-ability and one low-ability student. The research, descriptive in nature, employs qualitative methods using written assignments and interviews for data collection. This study's analysis involved condensing data, presenting findings, and drawing conclusions. The findings reveal distinct approaches between high and low mathematical ability subjects. High-ability students consistently apply all three metacognitive skills (planning, monitoring, and assessment) across each problem-solving stage. Conversely, low-ability students demonstrate a limited use of metacognitive skills. While they employ planning at each stage, during implementation and result review, they primarily engage in planning and monitoring, neglecting assessment. Ultimately, it underscores the critical role of metacognitive skills in mathematical problem-solving, highlighting differences in their application between students of varying mathematical abilities.

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1. INTRODUCTION

In Indonesia, mathematics is a subject that must be studied (Afriansyah et al., 2019) at every level of education, from elementary, junior high, and high school to tertiary institutions and underlies various branches of knowledge. Activities carried out in everyday life, from small things to increasingly advanced technological developments, cannot be separated from mathematics. Mathematics has many uses, including calculating the weight of objects, determining selling prices, developing hardware and software, and overcoming various conflicts between people. Humans need mathematics to avoid many difficulties in their daily lives. Therefore, mathematics is essential to learn.

Mathematics is a field of study that can train problem solving skills. This is in accordance with the objectives of learning mathematics in the first point formulated in SK BSKAP No. 33 of 2022 concerning Amendment to the Decree of the Head of the Standards, Curriculum and Education Assessment and Education Assessment Agency, Ministry of Education, Culture, Research and Technology Number 008/H/KR/2022 concerning Learning Outcomes in Early Childhood Education, Basic Education Levels, and Secondary Education in the Independent Curriculum, that students understand mathematics learning material in the form of facts, concepts, principles, operations, and mathematical relations and apply them flexibly, accurately, efficiently, and precisely in solving mathematical problems (BSKAP, 2022). Based on the objectives of learning mathematics above, problem solving is one of the aspects that must be achieved by students.

Problem solving is one of the most important tools in learning mathematics. Problem solving is very important because it can be useful as a means of learning new mathematical ideas and skills so that students are able to get good results. A person with problem solving skills is able to develop critical thinking skills and strengthen math skills (Pathuddin et al., 2019).

Polya (Novita & Widada, 2018) suggests four steps that need to be considered in problem solving, namely: (1) understanding the problem; (2) make a solution plan; (3) implement the solution plan; and (4) re-examine the results obtained. When properly observed, problem solving is carried out based on the knowledge of cognition, as well as the regulation of cognition which is a component of metacognition. Mathematical problem solving can be improved through learning based on metacognition strategies (Telaumbanua et al., 2017).

Metacognition is widely used as an “umbrella term” to refer to a person's various cognitive processes (Craig et al., 2020). Metacognitive is very important in solving math problems. Metacognitive in problem solving helps students to recognize the problem to be solved, to distinguish what the problem really is, and to understand how the solution is. This is supported by the results of Wahyuddin's research (2016). which shows that metacognition has a positive effect on problem solving abilities. Metacognitive has two basic components which include metacognitive knowledge and metacognitive skills.

Metacognitive skills are mental abilities in cognitive structures that are consciously regulated, controlled, and examined for their thought processes (Azizah et al., 2019). Students with well-trained metacognitive skills can know how to learn the right way for themselves, so that students can organize and assess their learning process. This is able to help students understand the problems and strategies used in solving mathematical problems, so they are able to determine the right steps in solving problems and are able to determine the solution (Kurniawan et al., 2019).

Each student has a different way of solving the math problems encountered. This happens because of differences in students' mathematical abilities, there are students who

have high, medium, and low mathematical abilities. Differences in students' mathematical abilities have an effect on ways of thinking in receiving and managing information when solving problems (Isroil et al., 2017). This difference in mathematical ability can result in differences in the metacognition processes carried out by students when solving mathematical problems. But not all students are able to involve their metacognition processes in solving mathematical problems (Marliana & Aini, 2021).

In solving problems, students experience difficulties when given non-routine questions. In short, non-routine problems require mastery of mathematical concepts and principles first, while routine problems are just daily routines that allow students to master basic mathematics (Abdullah et al., 2017). In solving non-routine questions, students tend to solve questions without understanding the information needed and do not re-check the answers that have been written. This happens because students do not consider their metacognitive skills in solving a given problem. Teachers also need to know an overview of students' metacognitive skills in solving math problems to design appropriate learning strategies.

Further research Wulandari et al. (2019) shows that students' metacognition skills in solving problems in the planning and evaluation aspects can be said to be lacking, while in the monitoring aspect it can be said to be quite good. Bennu & Multazam (2021) show that: (1) Subjects with a high level of mathematical ability bring up all components of metacognitive skills, namely prediction, planning, monitoring, and evaluation in solving problems with sequential and repetitive patterns; (2) Subjects at moderate level of mathematical ability bring up all components of metacognitive skills namely prediction, planning, monitoring, and evaluation, but the patterns are not sequential and repetitive; (3) Subjects with a low level of mathematical ability raise the components of metacognitive skills, namely prediction, planning, and evaluation in solving problems with incomplete and non-repetitive patterns.

The purpose of this study was to profile the metacognitive skills of SMPN 3 Palu students in solving mathematical problems in terms of mathematical abilities.

2. METHOD

In this study used a descriptive approach to the type of qualitative research. The subjects of this study were two class VIIJ students of SMPN 3 Palu consisting of one high ability student and one low ability student. This research was conducted at SMPN 3 Palu, which is located at Jalan Kemiri No. 35, Kamonji, West Palu District, Palu City, Central Sulawesi in the odd semester of the 2022/2023 school year. The difference in metacognitive skills between subjects with moderate abilities and subjects with high and low abilities is less significant. The metacognitive skills of subjects with moderate mathematical abilities are not much different from subjects with high mathematical abilities who have been able to surpass them (Hidayah & Nabila, 2022). Therefore, the researcher chose 2 subjects, namely students with high mathematical abilities and students with low mathematical abilities. Data collection techniques using written assignments and interviews.

The credibility test was carried out using time triangulation. Time triangulation is carried out by giving the first written assignment in the form of a description of fractional operations and then conducting interviews to find out more about the students' metacognitive skills in the first written assignment, then one week or even two weeks will be carried out again giving a second written assignment by providing a description of fractional operations which is equivalent to the first written assignment, then a second interview is conducted to find out more about the students' metacognitive skills in the second written assignment.

This study used two instruments, namely the main instrument, namely the researcher himself, and supporting instruments, namely written assignment sheets and interview guidelines. Before a written assignment is used in research, the written assignment is first validated by a lecturer in the Mathematics Education Study Program, FKIP Tadulako University. Students with high and low mathematical abilities will be given written assignment sheets in the form of questions about fractional operations in the form of descriptions, then will be interviewed in depth when solving problems at each step of the Polya.

Data analysis in this study was carried out with reference to qualitative data analysis according to (Miles et al., 2014), namely data condensation, data display, drawing and verifying conclusions.

3. RESULTS AND DISCUSSION

3.1. Results

The grouping of students based on mathematical abilities, namely students with high mathematical abilities as many as 7 people and students with low mathematical abilities as many as 5 people. The process of selecting subjects from each group is taken at least one student. Furthermore, one student was selected from each group, FA to represent a group of high-ability students and FD to represent a group of students with low abilities. The determination of the 2 subjects is based on daily test scores in the odd semester mathematics subject for the 2022/2023 school year, recommendations for mathematics teachers, student willingness, domicile of residence, and student communication skills.

Excerpts from the researcher's interview with the subject of FA at M1 for planning metacognitive skills in understanding the problem are presented as follows:

IRM102 : First of all, what did you do when you were first given a question?
FAM102 : Read the question first.
IRM103 : What for brother?
FAM103 : Let's understand the contents of the question.

Based on the results of the M1 written assignment and the interviews, it was found that in an effort to understand the problem, the FA subject first read the questions/problems first in a calm manner with the aim of getting the information contained in the questions so that the problem solving process is more focused and in accordance with the aims and objectives of the questions.

Excerpts from the researcher's interview with the subject of FA on M1 for monitoring metacognitive skills in understanding the problem are presented as follows:

IRM104 : How to?
FAM104 : Read it carefully and thoroughly
IRM105 : How come?
FAM105 : To get important information in the problem.

Based on the results of the M1 written assignment and interviews, it was found that in an effort to find out the intent and purpose of the questions and to obtain information from the questions, FA subjects checked what was understood from the questions by reading the questions carefully and thoroughly. FA subjects believed that after looking at it again by reading carefully and carefully they would understand the problem well so that they would get important information from the problem.

Excerpts from the researcher's interview with the FA subject at M1 for metacognitive skills in assessing the problem understanding are presented as follows:

IRM106 : Then after reading, what information is obtained from the problem?
FAM106 : Known and asked questions.

IRM109 : Can you write down what is known and asked in the questions.
FAM109 : (Rereading the question) Hmm.. you can
IRM110 : What is known from the problem?
FAM110 : Known girls get14 part.Boys get24 share and the husband gets the inheritance28.750.000.
IRM111 : Which24 where are you from
FAM111 : From$124 + 124$, right twice as much as girls.
IRM112 : Is there any other information to know?
FAM112 : There isn't any.
IRM113 : Then what is asked.
FAM113 : Asked how much inheritance was given to daughters and sons.
IRM114 : What makes you sure that that is what is known from the problem?
FAM114 : Because there is a part of the problem that is important to work on the problem.
IRM115 : For those asked?
FAM115 : Because there is a question mark.

Based on the results of the M1 written assignment and interviews, it was found that to see the efforts that had been made in understanding the problem, FA subjects examined or reflected on the information obtained through the strategy used and paid attention to the problem again. This can be seen that FA subjects can explain information about what is known and asked about the questions properly and correctly orally and in writing. FA subjects believe that the information explanation regarding what is known and asked is appropriate.

Excerpts from the researcher's interview with the subject of FA at M1 for planning metacognitive skills in making a solving plan are presented as follows:

IRM116 : After you know the information about what is known and asked, what will you do next?
FAM116 : Doing search for the share of the husband and the total inheritance.
IRM117 : Furthermore.
FAM117 : Searching for the inheritance of daughters and sons.

Based on the results of the M1 written assignment and the interviews, it was found that the FA subject carried out the planning process in developing the strategy to be used in solving the problem, namely finding the husband's share, then the total inheritance and finally looking for the inheritance of daughters and sons.

Excerpts from the researcher's interview with the subject of FA on M1 for monitoring metacognitive skills in making a solution plan are presented as follows:

IRM118 : Apart from this plan, do you have any other plans?
FAM118 : (Reviewing the question) Nothing sis.
IRM119 : The reason?
FAM119 : That's all I know and I think that's the way.

Based on the results of the M1 written assignment and the interview, it was found that the FA subject checked the flow of problem solving by monitoring the strategies used were on the right track. In this case the FA subject stated that the strategy that had been prepared was sufficient to achieve the goal and could be used to solve the problem after reviewing the questions given.

Excerpts from the researcher's interview with the subject of FA at M1 for metacognitive skills assessment in making a solution plan are presented as follows:

IRM120 : In your opinion, this plan can be used to solve the problem?
FAM120 : Can.

IRM121 : Why?
FAM121 : Because you can solve the problem correctly.

Based on the results of the M1 written assignment and interviews, it was found that the FA subject checked the suitability of the problem solving flow plan. Subject FA stated that the plan that had been prepared was sufficient and believed that it could be used to solve the problem so that no other strategy was deemed able to solve the problem.

FA subject's written answer in carrying out the M1 solving plan in the following figure.

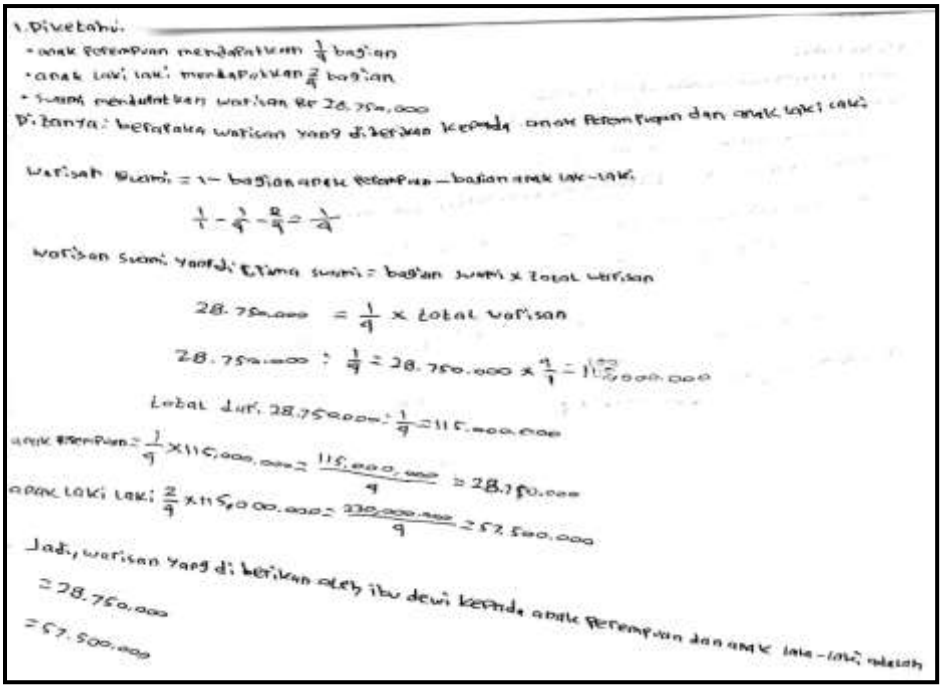

Figure 1.FA subject's written answer in carrying out the M1 solution plan

Figure 1 shows FA subjects carrying out the planning process by writing down the formula to be used so that they can implement the strategy that has been prepared in detail. Subject FA looked for the husband's share of inheritance first, then looked for the total inheritance left by Ibu Dewi and then looked for the amount of inheritance received by daughters and sons. The FA subject checks and corrects calculation errors and draws conclusions based on the steps taken.

Excerpts from the researcher's interview with the subject of FA at M1 for planning metacognitive skills in implementing the solving plan are presented as follows:

IRM122 : After you made the next plan, what did you do?
FAM122 : Count it.
IRM123 : Explain how did you calculate the problem?
FAM123 : Write down the formula for finding the husband's share. 1-girls section-share of boys = 1-14-24=14
IRM124 : Why use the adek subtraction operation?
FAM124 : Look sis, this is what the husband's part wants to look for. So to get the rest you have to subtract sis, the wife's share is reduced by the daughter's and son's shares.
IRM125 : How to get14 ?
FAM125 : Look for the KPK first.
IRM126 : Furthermore.
FAM126 : 44-14-24 then the top is subtracted4-1-2 so that14

IRM127 : What's next?
FAM127 : Dividing the husband's inheritance by the husband's share.
IRM128 : Where's that from bro?
FAM128 : 28.750.000 =14 total inheritance to be28.750.000 14 = 28.750.000 × 41 =115.000.000.
IRM129 : Why can it change like that?
FAM129 : What you are looking for is the total inheritance, sis, just moved the segment so it changes to . 28.750.000 14
IRM130 : Then why28.750.000 14 transformed into28.750.000 × 41?
FAM130 : The rules sis division of fractions can change to multiplication but which14 turned into41
IRM131 : Continue.
FAM131 : To find the total inheritance of the daughter14 115.000.000 = 115.000.000 4 = 28.750.000.
IRM132 : From where14 115.000.000?
FAM132 : 14 girls section and115.000.000 of the total inheritance.
IRM133 : Means?
FAM133 : Girls section total inheritance.
IRM134 : Furthermore.
FAM134 : To find the total inheritance of sons24 115.000.000 . 24 is the son's share multiplied by the total inheritance equals 2 115.000.000 = 230.000.000 and 41 = 4 means =230.000.000 4 = 57.500.000

Based on the results of the M1 written assignment and the interview, it was found that the FA subject carried out the planning process by writing down the formula to be used and carrying out the strategy that was prepared in detail to get the desired results. FA subjects think about and express about the plans that are thought of when carrying out various possible problem solving strategies.

Excerpts from the researcher's interview with the FA subject at M1 for monitoring metacognitive skills in implementing the solution plan are presented as follows:

IRM135 : There are several tipp-ex, why sis?
FAM135 : Because it's wrong.

Based on the results of M1's written assignments and interviews, it was found that FA subjects checked and corrected calculation errors when solving problems. This is visible because there are several x-types and numbers that are replaced.

Excerpts from the researcher's interview with the subject of FA at M1 for metacognitive skills assessment in implementing the solution plan are presented as follows:

IRM136 : Means the answer is obtained?
FAM136 : So, the inheritance given by the mother goddess to daughters and sons is daughters28.750.000 for boys57.500.000.
IRM137 : How come?
FAM137 : Because what is asked is how much inheritance is given to daughters and sons.

Based on the results of the M1 written assignment and interviews, it was found that the FA subject assessed the results obtained by making conclusions and checking the suitability of the results obtained with the purpose of the question so that the subject believed the answers were correct. The FA subject can also provide the right reasons for implementing the solving steps taken.

Excerpts from the researcher's interview with the FA subject at M1 for planning metacognitive skills in re-examining the results obtained are presented as follows:

IRM138 : After you get the results, what do you do?
FAM138 : read it.
IRM139 : What for?
FAM139 : To check correct or not.
IRM140 : How long did you check it?
FAM140 : 5 minutes
IRM141 : Is such time enough?
FAM141 : Enough.
IRM142 : Why?
FAM142 : Because time is enough to see how.

Based on the results of the M1 written assignment and interviews, it was found that the FA subject thought about and expressed how to check the steps that had been taken. In planning to re-check, the FA subject re-read the work that had been done and estimated that it would take around 5 minutes to re-check on the grounds that this time was sufficient.

Excerpts from the researcher's interview with the FA subject at M1 for monitoring metacognitive skills in re-examining the results obtained are presented as follows:

IRM143 : How do you check whether it's true or not?
FAM143 : From known to the end result.
IRM144 : What do you mean the end result?
FAM144 : Answer inheritance daughter and son.

Based on the results of M1's written assignments and interviews, it was found that to check whether the completion steps were on the right track or not, FA subjects looked back at the completion steps from start to finish to check for possible errors in writing and calculations.

Excerpts from the researcher's interview with the FA subject at M1 for metacognitive skills assessment in re-examining the results obtained are presented as follows:

IRM145 : Is your sister's path correct?
FAM145 : Already.
IRM146 : Do you have another way?
FAM146 : There is
IRM147 : How to?
FAM147 : By adding the daughter's inheritance plus the son's plus the wife's inheritance.
IRM148 : How come?
FAM148 : To find the total inheritance, if it is added to the three of them, it can produce the total inheritance, which means it is correct.

Based on the results of M1's written assignment and interviews, it was found that the subject FA considered the results of the investigation carried out to be correct. FA subjects reviewed whether the results obtained were correct or not by using another method, namely adding up the daughter inheritance, son inheritance and the inheritance received by the wife.

Excerpts from the researcher's interview with the subject of FD on M1 for planning metacognitive skills in understanding the problem are presented as follows:

IRM102 : What did you do when you were first asked questions?
FDM102 : Read it bro.
IRM103 : What are you reading for?
FDM103 : Let's find out.

Based on the results of the M1 written assignment and the interviews, it was found that in an effort to understand the problem the FD subject first read the questions calmly in order to get the information contained in the questions so that the problem solving process is more focused and in accordance with the intent and purpose of the questions.

Excerpts from the researcher's interview with the subject of FD on M1 for monitoring metacognitive skills in understanding the problem are presented as follows:

IRM104 : How to?
FDM104 : Read carefully
IRM105 : Why is it like that sister?
FDM105 : Let's understand the problem.

Based on the results of the M1 written assignment and interviews, it was found that the FD subject checked what was understood from the questions by reading the questions carefully in an effort to find out the intent and purpose of the questions and to obtain information from the questions. The FD subject believes that after looking at it again by reading it carefully they will understand the problem well so that they get important information from the problem.

Excerpts from the researcher's interview with the subject of FA on M1 for metacognitive skills assessment in understanding the problem are presented as follows:

IRM108 : Can you write down what is known and asked in the problem?
FDM108 : It is known that a daughter gets14 share, a son gets twice as much share as a daughter and the rest will be given to her husband.
IRM109 : Other information about what is known from the problem?
FDM109 : Hmm.. Nothing.
IRM110 : Why?
FDM110 : Because that's all that matters in the question.
IRM111 : As for the questions asked about the younger sibling?
FDM111 : How much inheritance did Mother Goddess give to a daughter and a son?
IRM112 What makes you sure that that is what is known from the problem?
FDM112 Because it's important.
IRM113 : According to the sister for what is known there is still something missing?
FDM113 : If I understand already bro.
IRM114 : What made you sure that that was what was being asked in the question?
FDM114 : There's a question mark.

Based on the results of M1's written assignments and interviews, it was found that in order to see the efforts made to be able to understand the problem, FD subjects did not realize the importance of checking the information obtained properly. This can be seen that the FD subject can explain information about what is asked correctly but for information about what is known to be inaccurate. Even though the information about what was asked was not written down, the FD subject was able to answer exactly what was asked in the question. The FD subject believes that the information about what is known and asked is appropriate, but the FD subject does not realize that the information about what is known is still not quite right.

Excerpts from interviews of researchers with FD subjects on M1 for skills metakognitif perencanaan dalamcreate a breakdown plan presented as follows:

IRM115 : After you know about what is known and asked from the questions, what do you do next?
FDM115 : Many daughters inherit.
IRM116 : Furthermore.
FDM116 : Many inherited sons.

Based on the results of the M1 written assignment and interviews, it was found that the FD subject carried out a planning process in developing a strategy to be used in solving the problem, namely looking for lots of inheritance from daughters, followed by lots of inheritance from boys.

Excerpts from the researcher's interview with the subject of FD on M1 for monitoring metacognitive skills in making a solution plan are presented as follows:

IRM117 : Apart from this plan, do you have any other plans?
FDM117 : I don't think there is.
IRM118 Why?
FDM118 That's all I know.
IRM119 What about the husband's share and the total inheritance of Ibu Dewi? Aren't you looking for it?
FDM119 Yes, it's not in the question.
IRM120 : So aren't you looking?
FDM120 : Because there wasn't one in the question, I didn't look for Sis.

Based on the results of the M1 written assignment and interviews, it was found that the FD subject was not aware of checking the suitability of the problem solving strategy that had been thought of. This can be seen when the FD subject states that there is no other strategy without realizing again that the strategy is still insufficient to be able to solve the problem properly.

Excerpts from the researcher's interview with the subject of FA at M1 for metacognitive skills assessment in making a solution plan are presented as follows:

IRM121 : Then according to you, the plan can be used to solve the problem?
FDM121 : Not too sure sis but later the answer is appropriate.

Based on the results of the M1 written assignment and interviews, it was found that the FD subject did not check the suitability of the problem solving flow plan. The FA subject stated that the strategy that had been prepared was sufficient but was not sure that the strategy that had been developed could be used to solve the problem properly.

The FD subject's written answers in carrying out the M1 solving plan are in the following figure

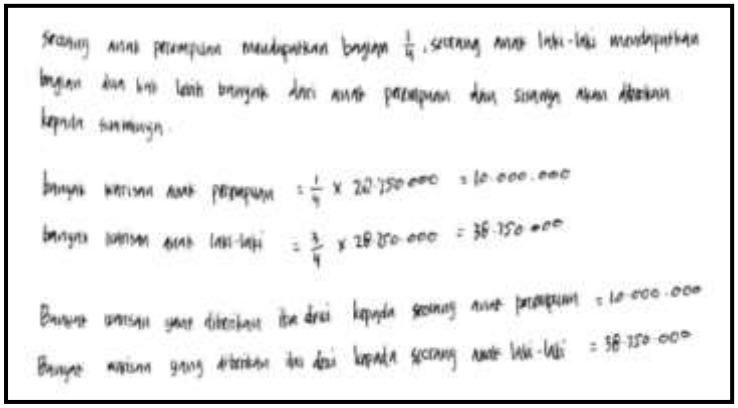

Figure 2.FD subject's written answer in carrying out the M1 solving plan

Figure 2 shows FD subjects carrying out the planning process by writing down the formula to be used so that they can carry out the strategy that has been prepared in detail. FD subjects are looking for more inheritance that daughters receive then sons. However, the formula for finding multiple inheritance of daughters and sons is still not quite right.

Excerpts from the researcher's interview with the subject of FD at M1 for planning metacognitive skills in carrying out the solving plan are presented as follows:

IRM122 : After making a plan, what next do you do?

FDM122 : Do formulas.
IRM123 : Explain how bro?
FDM123 : Many daughters inherit=14×28.750.000=10.000.000.
IRM124 : From where14×28.750.000
FDM124 : 14 girls section and28.750.000 husband's inheritance.
IRM125 : Furthermore.
FDM125 : Boy=34×28.750.000=38.750.000. 34 boys section and28.750.000 husband's inheritance.
IRM126 : Why the boys section34?
FDM126 : Hmm…. Just think about it and write it down
IRM127 : From the question, how many shares do the men get?
FDM127 : In terms of a boy getting twice as much as a girl, that's why I think34 sister
IRM129 : Oh yes deck. Why must the inheritance of daughters and sons be multiplied by the husband's inheritance?
FDM129 : Because sis that's all there is in the question.

Based on the results of M1's written assignments and interviews, it was found that the FD subject carried out the planning process by writing down the formula to be used and implementing the strategy drawn up to get the desired results. FD subjects think about and express about the plans they think about when carrying out various possible problem-solving strategies.

Excerpts from the researcher's interview with the subject of FD on M1 for monitoring metacognitive skills in implementing the solution plan are presented as follows:

IRM130 : There are some correction ink, why?
FDM130 : I wrote it wrong.

Based on the results of M1's written assignments and interviews, it was found that the FD subject checked and corrected writing errors when solving problems. This can be seen because there are several x-types and numbers that are replaced, but the calculation results obtained by the FD subject are not correct.

Excerpts from the researcher's interview with the subject of FD at M1 for metacognitive skills assessment in implementing the solution plan are presented as follows:

IRM131 : Means the answer is obtained?
FDM131 : Many inheritances given by Dewi's mother to her daughter are similar to10.000.000 and boys are equal38.750.000.
IRM132 : Why is the answer like that?
FDM132 : Because that's what you get.
IRM133 : The answer you got is correct?
FDM133 : Maybe it's true.

Based on the results of the M1 written assignment and interviews, it was found that the FD subject made conclusions but had not checked the suitability of the results obtained. It can be seen that the FD subject does not believe that the results obtained are correct because the FD subject also does not believe that the strategy that has been prepared can be used to solve the problem correctly. The subject of FA also could not give a precise reason for the implementation of the problem solving steps carried out.

Excerpts from the researcher's interview with the subject of FD at M1 for planning metacognitive skills in re-examining the results obtained are presented as follows:

IRM134 : After solving the problem, what else do you do?
FDM134 : Replay.

IRM135 : What for?
FDM135 : Afraid something is wrong.
IRM136 : How long did you look at it again?
FDM136 : 1 minute.
IRM137 : Is such time enough?
FDM137 : Yes, because it's short.

Based on the results of the M1 written assignment and interviews, it was found that the FD subject thought about and expressed how to check the steps that had been taken. The FD subject plans to re-check by reviewing the steps that have been taken and estimating that it will take around 1 minute to re-check on the grounds that this time is sufficient.

Excerpts from the researcher's interview with the subject of FD at M1 for monitoring metacognitive skills in re-examining the results obtained are presented as follows:

IRM138 : How do you check that you are not wrong?
FDM138 : Read from top to end.
IRM139 : What does it mean from top to end?
FDM139 : From what is known to the final answer sis.

Based on the results of M1's written assignments and interviews, it was found that to check whether the completion steps were on the right track or not, the FD subject looked back at the completion steps from start to finish to check for possible errors in writing and calculations.

Excerpts from the researcher's interview with the subject of FD at M1 for metacognitive skills assessment in re-examining the results obtained are presented as follows:

IRM140 Is your sister's path correct?
FDM140 I'm not too sure bro.
IRM141 Do you have another way?
FDM141 I don't think there is anymore.

Based on the results of M1's written assignments and interviews, it was found that the FD subject could not judge that the results of the investigations carried out were correct. The FD subject was unsure of the results obtained and did not review the results obtained using other methods

3.2. Discussion

Based on the data analysis conducted by the researcher, the metacognitive skill profiles of SMPN 3 Palu students with high and low mathematical abilities in solving mathematical problems in terms of mathematical abilities were obtained as follows:

Profile of Students' Metacognitive Skills with High Mathematical Ability in Problem Solving

At the stage of understanding the problem, the subject consciously determines what must be done to understand the problem by first reading the problem calmly to get the information in the problem. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring the steps taken in understanding the problem, namely checking what is understood from the problem by reading the problem carefully and thoroughly. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. Subjects also seemed aware of checking the information obtained from the questions, namely writing and explaining information about what was known orally and in writing and believed that the information obtained was appropriate. Based on this it was concluded that the subject involved his metacognitive skills through assessment.

At the stage of making a problem-solving plan, the subject consciously determines what to do to prepare a settlement plan, namely carrying out the planning process in developing a strategy to be used in solving the problem. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring what is being done in compiling a problem-solving plan, namely checking the flow of problem-solving by reviewing the questions and the strategies used are on the right track. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. The subject also seemed conscious to re-check the correctness of the strategy being carried out, namely checking the suitability of the problem-solving flow plan so that the plan that had been prepared could be used to solve the problem. Based on this it was concluded that the subject involved his metacognitive skills through assessment

At the stage of carrying out the problem-solving plan, the subject is aware of planning the implementation of the problem-solving strategy, namely thinking and expressing the plans that are thought of when carrying out the strategy that is prepared in detail to get the desired results. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring the implementation of problem solving by checking and correcting calculation errors when solving problems. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. The subject also seemed conscious in assessing the suitability of the initial plan with the results obtained, namely checking the suitability of the results obtained with the purpose of the question, and giving the right reasons for implementing the solving steps taken. Based on this it was concluded that the subject involved his metacognitive skills through assessment.

At the stage of re-examining the results obtained, it can be seen that the subject is aware of planning what to do to check the completion steps, namely thinking and expressing how to check the steps that have been taken by re-reading and estimating the time to re-check. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring the plan to check the steps for solving the problem, namely looking back at the completion steps from start to finish to check for possible errors in writing and calculations. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. The subject also seemed aware of re-examining the problem solving steps, namely assessing the results of the investigation carried out were correct using other methods. Based on this it was concluded that the subject involved his metacognitive skills through assessment.

The results of the study for students with high mathematical abilities showed that all metacognitive skills emerged at each of Polya's steps in solving mathematical problems. This is in line with (Sudia, 2015; Wulandari et al., 2019; Pathuddin et al., 2019) in his research which concluded that high-ability students involve all their metacognitive skills for each stage of problem solving according to Polya.

Profile of Students' Metacognitive Skills with Low Mathematical Ability in Problem Solving. At the stage of understanding the problem, the subject is aware of planning what to do to understand the problem by reading the questions first to get the information in the questions. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring the steps taken in understanding the problem, namely checking what is understood from the problem by reading the problem carefully. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. The subject also seemed aware of assessing what information was asked; that is checking the information obtained properly and explaining the information regarding the person being asked orally and in writing and making sure

that the information about what is being asked is appropriate. However, the subject is not yet aware of assessing the determination of information about what is known and sufficient conditions to solve the problem; namely not checking the information obtained properly so that information about what is known is not quite right so that it is not enough to be able to solve the problem. Based on this it was concluded that the subject had not fully involved his metacognitive skills through assessment.

At the stage of making a problem solving plan, it can be seen that the subject is aware of planning what to do to solve the problem, namely carrying out the planning process in developing a strategy to be used in solving the problem. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also not aware of monitoring what is being done in preparing a problem-solving plan, that is, he is not aware of checking the suitability of the problem-solving strategy that has been thought of so that the strategy is still insufficient to be able to solve the problem properly. Based on this it was concluded that the subject had not involved his metacognitive skills through monitoring. The subject also seemed not aware of checking again the correctness of the strategy being carried out, namely not checking the suitability of the problem-solving flow plan and not being sure that the strategy that had been prepared could be used to solve the problem properly. Based on this it was concluded that the subject had not involved his metacognitive skills through assessment.

At the stage of implementing the problem-solving plan, it can be seen that the subject is aware that in planning the implementation of the problem-solving strategy, it has been determined in detail, that is, to think about and express the plan that was thought of when carrying out various possible problem-solving strategies. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring the implementation of problem solving, namely checking and correcting writing errors when solving problems. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. The subject also seemed unaware of assessing the implementation of the problem-solving strategy undertaken, that is, the subject had not been able to provide proper reasons for the implementation of the problem-solving steps carried out and had not checked the suitability of the results obtained so that the subject did not believe the results obtained were correct. Based on this it was concluded that the subject had not involved his metacognitive skills through assessment.

At the stage of re-examining the results obtained, it can be seen that the subject is aware of planning what to do to check the completion steps, namely thinking and expressing how to check the steps that have been taken by re-reading and estimating the time to re-check. Based on this it was concluded that the subject involved his metacognitive skills through planning. The subject is also aware of monitoring the plan, namely looking back at the completion steps from start to finish to check for possible errors in writing and calculations. Based on this it was concluded that the subject involved his metacognitive skills through monitoring. The subject also seemed unaware of assessing the plan to check the steps for solving the problem, namely not being sure of the results obtained and not reviewing the results obtained using other methods. Based on this it was concluded that the subject had not involved his metacognitive skills through assessment.

The results of the research for students with low mathematical abilities show that not all metacognitive skills appear at every step of Polya in solving mathematical problems. This is in line with (Sudia, 2015; Wulandari et al., 2019) in his research which stated that students with low abilities did not involve all of their metacognitive skills for each stage of problem solving according to Polya. Where according to (Sudia, 2015), students who have low abilities only involve their metacognition through planning activities in problem

solving according to Polya. Students who have low mathematical abilities only involve their metacognitive through the monitoring stage (Muliawati, 2016). Wulandari et al. (2019) also stated that students with low ability levels did not involve evaluation activities at each Polya stage.

4. CONCLUSION

When solving mathematical problems, subjects with high mathematical abilities involve all three metacognitive skills (planning, monitoring, and assessing) for each stage of Polya's problem-solving.When solving math problems, subjects with low math abilities involve only one metacognitive skill (planning) for each stage of Polya's problem-solving and involve two metacognitive skills (planning and monitoring) for several stages of Polya's problem-solving (implementing the solving plan and re-checking the results obtained).

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ANALYSIS OF MATHEMATICAL CONNECTION ABILITY IN SOLVING HOTS QUESTIONS ON ARITHMETIC SEQUENCE

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ABSTRACT

Mathematical connection ability needs to be analyzed so that teachers can get an overview of students' mathematical connection abilities and develop learning strategies to improve students' mathematical connection abilities. This study explores the mathematical connection abilities of class XI MAN 2 Kota Palu students in solving HOTS arithmetic sequence problems. The type of research is qualitative and uses student interview results as data. The results of this research show that mathematical connections high-ability students demonstrate strong connections between arithmetic series and algebra, exponents, and roots, and apply these concepts in real-life and economic contexts. Moderately skilled students link arithmetic sequences to algebra but struggle with economic connections. Low-ability students face challenges linking mathematical concepts, applying arithmetic series to daily life, and connecting it with economics. Understanding these abilities helps teachers tailor strategies to enhance students' mathematical connections, aiding their problem-solving skills.

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1. INTRODUCTION

Mathematics is one of the scientific disciplines studied at educational levels ranging from elementary school to tertiary education. Mathematics is essential to teach to students because mathematics is closely related to everyday life and relies on thinking processes in solving problems. As Bernard et al., (2018) expressed, mathematics has a vital role in living things that can be used in everyday life. Mathematics is generally known as a science with hierarchically interrelated concepts, so learning mathematics must be structured and

systematic. This is in accordance with Sumarmo (2013) who said that mathematics is a science that has characteristics as a structured, hierarchical, and systematic science, which implies that the concepts and principles in mathematics are interrelated with one another. In other words, when students learn mathematical ideas or concepts, they need previous ideas or knowledge and even have to learn previous concepts related to the concepts to be studied or the problems encountered so they can quickly solve them.

In mathematics, linking mathematical ideas or concepts is called mathematical connection. The understanding of mathematical connections expressed by Putri & Riwayati, (2017) that mathematical connection is associating a mathematical concept with other mathematical concepts, with other subjects, and with applications in everyday life. Ausubel (Hasbi & Inayah, 2016) states that if students learn to understand a new knowledge based on what they already have it means they can connect a concept that is being studied. There are three indicators of mathematical connection ability formulated by NCTM (2000) namely: 1) Recognizing and connecting between mathematical ideas; 2) Recognize and apply mathematics in contexts outside mathematics and 3) Demonstrate the interconnection of mathematical ideas and build on each other to produce a unified whole of knowledge.

Mathematical connection skills are very necessary for students because mathematics is a unified whole, where one concept is interconnected with other concepts, or in other words, studying certain concepts in mathematics requires prerequisites from other concepts (Septian & Komala, 2019). Regarding the importance of learning mathematics, NCTM (2000) argued that one of the importance of learning mathematics, namely learning to associate ideas. Apart from that, mathematical connection skills can also support improving thinking abilities, including high-level thinking abilities. If students can find connections between mathematical concepts and the relationship between mathematical concepts and everyday life, this can give rise to new thoughts or ideas in solving mathematical problems such as Higher Order Thinking Skills (HOTS) questions.

The HOTS questions in question are an instrument that can assess students' high-level thinking abilities so that students do not just remember or restate, but students are expected to be able to develop their ideas (Giani et al., 2015). Higher-order thinking is an analysis of understanding new questions or information by using and applying previous experience, to obtain an answer in a difficult situation and achieve a goal (Amalia & Hadi, 2020). Thus students' mathematical connections can be trained by solving HOTS questions because these questions indirectly require students to be able to connect and develop ideas in solving them.

In the 2013 curriculum, HOTS type questions began to be developed because the 2013 curriculum requires students not only to have the ability to solve low-level questions, but students must be able to use their thinking skills at a higher level and use mathematical forms to solve problems related to everyday life. . In the 2013 curriculum, students are also required to master HOTS questions (Kusuma & 'Adna, 2021).

The Ministry of Education and Culture (2017) explains that HOTS questions are a measurement instrument used to measure high-level thinking abilities, namely thinking abilities that do not just remember, restate, or refer without processing (recite).(Fikriani & Nurva, 2020). In line with opinion Giani et al., (2015) that the HOTS question in test is an instrument that can assess students' high-level thinking abilities so that students do not just remember or restate, but students are expected to be able to develop their ideas and concepts. In preparing HOTS questions, operational verbs are needed. The choice of operational verbs must be appropriate and appropriate to the realm of intellectual ability that you want to measure. So the HOTS questions referred to in this research are questions that do not just remember, understand and apply but require students to be able to analyze questions or information and be able to develop ideas by connecting previously acquired mathematical concepts in solving problems.

Based on previous research conducted by (Ully & Jahring, 2021) shows that the mathematical connection abilities of students in class IX of SMP Negeri 1 Tanggetada are still relatively low. According to the results of an initial interview with a mathematics subject teacher at one of the secondary schools, it was discovered that the majority of students had difficulty connecting the material currently being studied with previous material, and students even tended not to be able to answer questions related to material outside mathematics and students were also unable to complete it. story problems related to everyday life because they are confused about connecting these questions with mathematical concepts and procedures (Ully & Jahring, 2021).

Based on this, students' mathematical connections still need to be improved, considering the importance of developing mathematical connections in students, especially in secondary school. A similar problem was also found in one of the schools which is equivalent to a secondary school, namely MAN 2 Palu City. After conducting interviews with mathematics teachers at the school, information was obtained that students in class So the teacher must re-teach previous concepts related to the concept to be studied. Apart from that, students also have difficulty using mathematical concepts in working on questions that require a description of concepts such as HOTS questions. Students are not used to working on HOTS questions so they have difficulty solving them. Most students can remember the formula but sometimes do not know when and how to apply the formula. Students also have difficulty associating mathematical concepts with other fields.The difference between previous studies was examining students' mathematical connection abilities based on the students' learning styles because in these schools there was still minimal information about learning styles, whereas this research will describe students' mathematical connection abilities in solving HOTS questions because based on interviews conducted by researchers, teachers did not yet have them. an overview of students' mathematical connection abilities so that they have not received appropriate learning strategies to improve mathematical connections, both students with high mathematical abilities, students with moderate mathematical abilities and students with low mathematical abilities.

Of the many mathematical materials studied, arithmetic series is one of the materials whose concepts are interrelated with other mathematical concepts. This material also has an important role when applied to everyday life and can be used in other fields of science. Therefore, researchers are interested in conducting research on analyzing students' mathematical connection abilities in solving HOTS problems.The expected results of this research are to obtain a description of students' mathematical connection abilities in solving HOTS arithmetic series problems for MAN 2 Palu City Students.

2. METHOD

The method used in this research is a descriptive method with a qualitative approach. This research was conducted at MAN 2 Palu City. The research will be carried out in the 2022/2023 academic year, even semester. This research took 3 students as research subjects. To get these 3 people, they will be selected based on their final semester exam scores in mathematics subjects consisting of students with high abilities, students with medium abilities and students with low abilities. To categorize subjects, the following criteria are used.

Table 1. Student Ability Criteria

Category	Criteria
High ability	n + SD$\geq \bar{x}$
Moderate ability	$\bar{x}$ −SD n + SD$\leq <\bar{x}$

Low ability	n SD< $\bar{x}$ −

Arikunto (2013)

In this research, the material used is arithmetic series.The research instrument uses written assignments in the form of HOTS questions and interviews to measure students' mathematical connection abilities based on mathematical abilities which are categorized into 3, namely high, medium and low abilities.Indicators of mathematical connection abilities used in this research can be seen in the following table.

Table 2. Mathematical Connection Capability Indicator

Mathematical Connection Capability Indicator	Activities carried out
1. Relate one mathematical concept to other mathematical concepts	Relate the concept of arithmetic sequences to algebraic calculation operations and the concept of exponents
2. Relate mathematical concepts to everyday life	Relate the concept of arithmetic series to everyday life
3. Relate mathematical concepts to other fields	Relate the concept of arithmetic series in economics

3. RESULTS AND DISCUSSION

3.1. Results

Based on the students' semester exam scores, 3 research subjects were obtained as follows.

Table 3. Student Ability Criteria

Subject	Mark	Criteria
ST	95	Tall
SS	81	Currently
SR	70	Low

The three research subjects were given written tests or assignmentsin the form of HOTS arithmetic series questions created by the researcher himself with two questions. After that, the subject was interviewed to obtain accurate data regarding mathematical connection abilities. Based on data analysis carried out on the subject, the following research results were obtained.

Indicators Link One Mathematical Concept to Other Mathematical Concepts

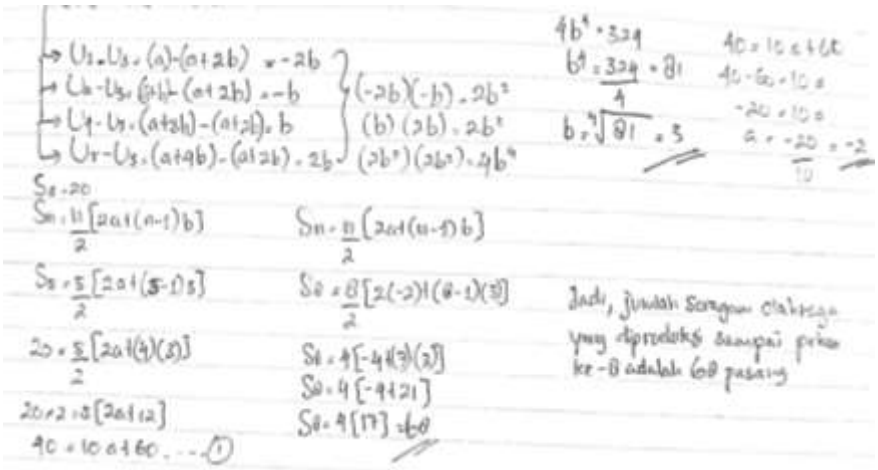

Figure 1. ST's Answer to Question Number 1

The picture above is the answer of a high-ability subject in which the subject was asked to determine the number of sports uniforms produced until the 8th week where it was known that the number of sports uniforms in the 5th week was 20 pairs with the condition that the number of sports uniforms in the 1st week , 2nd, 4th, and 5th minus week 3, then the product of the number of uniforms in weeks 1, 2, 4, and 5 is 324 pairs. Based on ST's answers and interview results, it shows that ST links several mathematical concepts in solving problems. Among them is the concept of arithmetic sequences, that is, and according to the ST question instructions, it is explained using the arithmetic operations of addition and subtraction, namely onwards. ST links the concept of exponents and root form, namely dividing by 4 and rooting both sides so . ST also correctly uses the concept of arithmetic series to obtain the value of a.$U_1 = a, U_2 = (a + b), U_3 = (a + 2b), U_4 = (a + 4b) U_5 = (a + 5b)(a) - (a + 2b) = -2b, (a + b) - (a + 2b) = -b 4b^4 = 324 b^4 = 81 = \sqrt[4]{81} = 3$

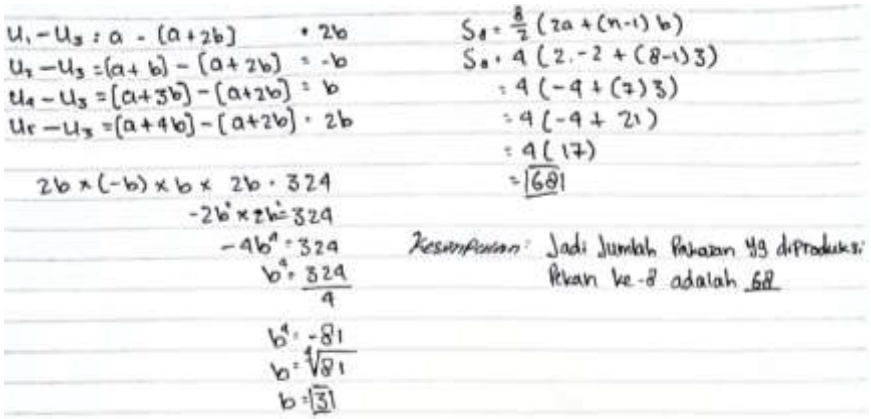

Figure 2. SS's answer to question number 1

In the picture above is the answer of a moderately capable subject which shows that the subject can write down the steps for solving problems using several concepts in mathematics, namely the concept of arithmetic sequences and linking them to the concept of addition and subtraction arithmetic operations. SS also uses the concept of exponents and roots, namely and . as well as using the concept of an arithmetic series to determine the number of clothes produced in the 8th week, namely $.U_1 = a, U_2 = (a + b), U_3 = (a + 2b), U_4 = (a + 4b) U_5 = (a + 5b) 4b^4 = 324 b = \sqrt[4]{81} = b S_8 = \frac{8}{2}(2a + (n - 1)b)$

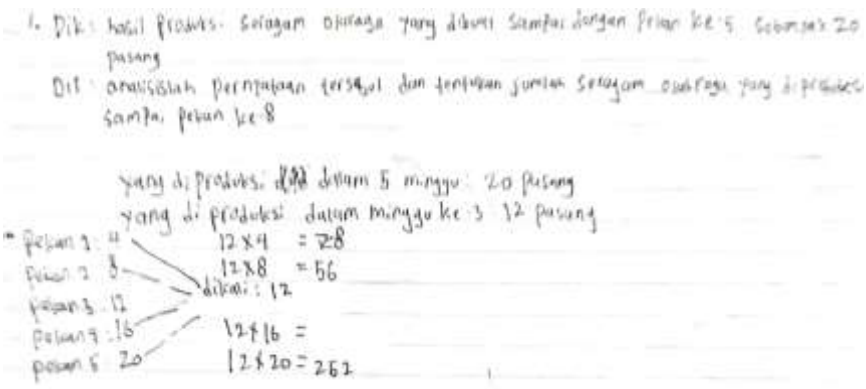

Figure 3. SR's answer to question number 1

From answer, SR is known that SR is not able to associate the concept of arithmetic sequences and series with other concepts. In the interview, SR also stated that he didn't really understand the questions given, but only knew what he knew and was asked about the questions, then SR also didn't know what material was involved in the questions and couldn't solve the questions correctly.

Indicator Linking Mathematical Concepts with Everyday Life

On the indicator of linking mathematical concepts to everyday life, data were obtained from subject interviews. Based on the results of the interview, it is known that ST can associate the concept of arithmetic series with everyday life. ST said that he had encountered the concept of arithmetic series in everyday life so he could give a simple example, namely for example in the first month I saved 10,000 then the next month it increased by 2,000 and so on until the tenth month. So to determine the amount of savings for 10 months, you can use the arithmetic series formula$S_n = \frac{n}{2}(2a + (n-1)b)$.

Based on the results of interviews conducted with SS subjects, it is known that SS can relate the concept of arithmetic series to everyday life. SS mentioned that the concept of arithmetic series can be used in everyday life, then SS said that arithmetic series are usually used to determine the number of chairs in a hall and SS can give concrete examples.

The results of interviews conducted with SR showed that SR was unable to relate the concept of arithmetic series to everyday life. From the interview it can be seen that SR does not understand the concept of arithmetic series and cannot provide simple examples regarding the use of the concept of arithmetic series in real life.

Indicators Link Mathematical Concepts in Other Fields

Figure 4. ST's answer to question number 2

In question number 2, the subject is asked to determine the amount of profit during the first year of his business activities, where it is known that the profit was IDR 700,000 in the fifth month and the total profit for seven months was IDR 4,620,000. Based on the answers and results of interviews with ST, it is known that ST can use the concept of sequences and arithmetic series as well as the SPLDV concept in solving problems in the field of economics. In the interview, ST said that the first concept that was linked was an arithmetic series to determine the first equation and then used the concept of an arithmetic series$U_n = a + (n-1)bS_n = \frac{n}{2}(2a + (n-1)b)$ to create the second equation [STM1 062]. Next, to obtain the values a and b, ST uses the SPLDV concept with the substitution and elimination method.

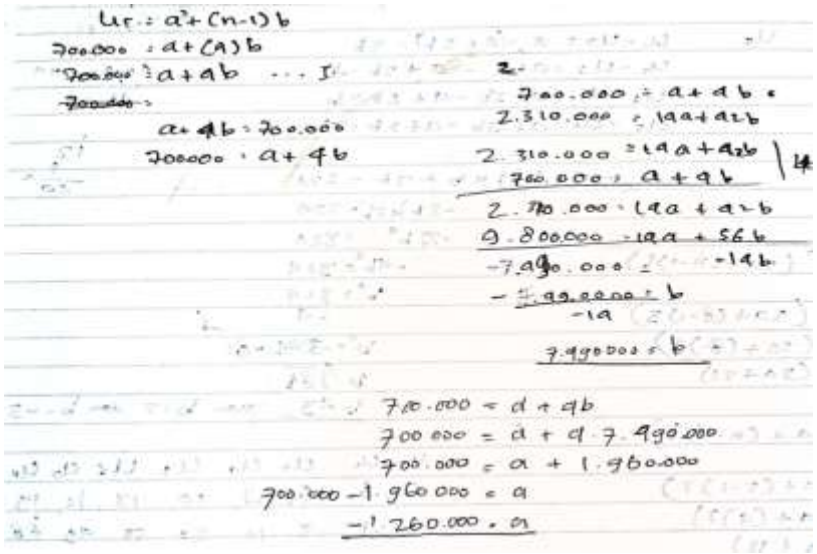

Figure 5. SS's answer to question number 2

Fromthe results of the answers and interviews conducted with SS found that SS was quite good at relating mathematical concepts in the field of economics, namely SS linked the concept of arithmetic sequences to make the first equation then linked the concept of arithmetic series to make the second equation [SSM1 054] and linked the SPLDV concept using the elimination method and substitution. However, SS cannot use algebraic arithmetic

operations properly so that it is wrong in solving the problem and unable to solve the problem correctly.$U_n = a + (n-1)b$

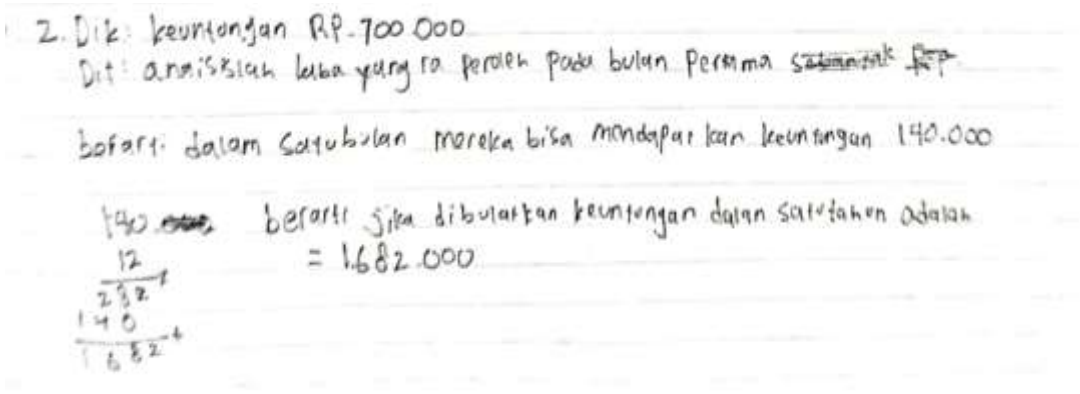

Figure 6.S R's answer to question number 2

Based onThe results of answers and interviews with SR revealed that SR was unable to relate the concept of arithmetic series to the field of economics. From the interview, SR stated that he did not understand how to do the questions and only wrote down what he knew and asked in the questions.

3.2 Discussion

a. Subject ST

In terms of indicators of linking one mathematical concept to another, ST is good at linking the concept of arithmetic series with the arithmetic operations of addition and subtraction, linking the concept of exponents and root forms and correctly using the concept of arithmetic series in solving problems. This shows that ST understands the relationship between mathematical concepts well so that they can use them in solving HOTS level questions. In line with Hurst's opinion in Rismawati et al., (2016) that concepts in mathematics are related to one another, therefore in solving mathematical problems a person can relate one concept to another concept.

Furthermore, the second indicator is linking mathematical concepts to everyday life. ST stated that he had encountered arithmetic series in everyday life and could provide simple examples of the use of arithmetic series concepts in real life. for the third indicator, ST is good at linking several mathematical concepts in solving problems in the field of economics, namely ST links the concept of arithmetic series to obtain equation (1) and arithmetic series to obtain equation (2). ST also links the SPLDV concept using the elimination and substitution method to determine the values a and b in the problem solving step. This shows that ST can understand and master the concepts used and can explain them well when interviewed. This is in accordance with opinion Rohmah & Warmi (2021) which states that mathematical connection skills help students master understanding concepts through connections between mathematical concepts and with concepts outside mathematics.

b. Subject SS

In linking one mathematical concept with other mathematical concepts, SS is good at linking several concepts in mathematics, namely the concept of arithmetic sequences$U_1 = a, U_2 = (a+b), U_3 = (a+2b), U_4 = (a+4b)$ $U_5 = (a+5b)$with the arithmetic operations of addition and subtraction, the concept of powers and root forms, namely$4b^4 = 324$ And$b = \sqrt[4]{81} = b$ and using the concept of arithmetic series to determine the number of clothes produced in the 8th week, namely$S_8 = \frac{8}{2}(2a + (n-1)b)$. SS is also good at

explaining the use of mathematical concepts in solving problems because he can understand the meaning of the questions and understand the interrelated concepts.In relating mathematical concepts to everyday life, SS stated that the concept of arithmetic series can be used in everyday life and is usually used to determine the number of chairs in a hall. SS is also able to explain and provide concrete examples regarding the application of the concept of arithmetic series in everyday life. In the third indicator SS is quite good at linking mathematical concepts with economics because in solving problems SS is only able to link the concept of arithmetic sequences to create equation 1, namely$U_5 = a + (n-1)b$then the equation is obtained. SS uses$700.000 = a + 4b$SPLDV concept but cannot relate to the concept of arithmetic series because they are confused about the next step to solve a problem that is slightly different from before. This is in accordance with the statement(Rohmah & Warmi, 2021)that students tend to get confused and have difficulties when they find problems that are presented differently. Even though SS was correct in using the concepts of arithmetic sequences and SPLDV, SS was unable to use algebraic calculation operations correctly so he solved the problem incorrectly and was unable to continue solving the problem because he did not understand the meaning of the problem. In accordance with Sudirman's opinion in Rohmah & Warmi (2021) stated that student errors occur because students forget the concepts studied before and do not understand the meaning of the questions.

b. SR Subject

In associating one mathematical concept with another, SR was unable to relate the concept of arithmetic sequences and series to other concepts. SR also stated that he did not really understand the questions given but only knew what he knew and was asked about the questions. It is possible that what happened was that SR forgot about the material for arithmetic sequences and series that he had studied and did not understand mathematical concepts well so that SR had difficulty working on questions that required high analysis such as HOTS questions. In accordance with the results of research conducted by Kempirmase et al. (2019) that students often forget the concepts related to the questions, making it difficult for them to complete questions, especially questions in the form of HOTS questions which are more contextual in nature and require high ability to analyze and evaluate. Furthermore, SR was not good at relating the concept of arithmetic series to everyday life and stated that he did not understand the concept of arithmetic series and could not provide simple examples regarding the use of the concept of arithmetic series in everyday life. This is because SR does not have a good conceptual understanding of mathematics so SR is often silent when interviewed. Meanwhile, in relating mathematical concepts to other fields, SR is not good at relating the concept of arithmetic series to the economic field. SR said he didn't understand how to do the questions correctly and only wrote down what he knew and asked in the questions. Thus it can be said that SR is not good at relating mathematical concepts to other fields.

4. CONCLUSION

The mathematical connection abilities of students with high mathematical abilities in solving HOTS questions series fulfil 3 indicators of mathematical connection ability. Namely, students who have high mathematical abilities (ST) and are good at relating the concept of arithmetic series to the arithmetic operations of addition and subtraction, relating the concept of exponents to the concept of roots, and relating the concept of arithmetic series to algebraic arithmetic operations, able to relate the concept of arithmetic series to everyday life. Then, the student correctly linked the concept of arithmetic series in economics. Students who have moderate mathematical ability (SS) meet two indicators of mathematical

connectivity ability, namely, linking the concept of arithmetic series with the arithmetic operations of addition and subtraction, linking the concept of exponents with the concept of root forms, linking the concept of arithmetic series with algebraic arithmetic operations. Then, he is good at relating the concept of arithmetic series to everyday life but cannot relate the concept of arithmetic series to the field of economics. The mathematical connection abilities of students with low mathematical abilities do not meet the three indicators of mathematical connection abilities. The indicators link one mathematical concept with other mathematical concepts for low-ability students who are good at linking the concept of arithmetic sequences and series with algebraic calculation operations and the concept of exponentiation with root forms. These students can also not relate the concept of arithmetic series to everyday life. They are not good at relating the concept of arithmetic series to economics.

SUGGESTION

It is best for students to practice a lot on questions that require critical thinking, such as HOTS questions, so that students can practice their thinking skills in connecting various knowledge or concepts they have, both concepts between mathematical topics and outside mathematics. Then teachers should pay more attention to students' mathematical connection abilities and be able to think about appropriate strategies or learning models to use that can improve students' mathematical connection abilities because having this ability can make it easier for students to solve problems. For other researchers who wish to conduct research on mathematical connection abilities, it is possible to expand the research subjects at both middle and high school education levels which are not used in this research.

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DIFFERENCES IN STUDENTS' MATHEMATICS LEARNING OUTCOMES BETWEEN OFFLINE AND ONLINE LEARNING AT SMP NEGERI 2 PALU

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ABSTRACT

This research aims to determine whether there are differences in student mathematics learning outcomes between offline and online learning at SMP Negeri 2 Palu. The research used a comparative method with a population of all students in class VIII, totalling 332 students. The sample was class VIII students who did offline and online learning, with different samples but the same abilities. The sampling technique is Purposive Sampling. The researchers took 60 samples consisting of 30 students each from classes A and B. The data collection technique was carried out by taking the even semester midterm test scores for the 2021/2022 academic year obtained by students during online learning and the even semester midterm test scores for the 2022/2023 academic year obtained by students during offline learning, with the same subject matter, namely the Pythagorean theorem. Provided that the material taught is equivalent during offline and online learning and has the same academic abilities: (1). Mathematics learning outcomes obtained an average score of 64.13 and 68.27 (2). Sig value. (2-tailed) 0.187 > 0.05. This means that H0 is accepted, and Ha is rejected. So, the research results show no difference in student mathematics learning outcomes between offline and online learning.

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1. INTRODUCTION

Authentic learning occurs through teacher interaction with students in a learning environment. The essence of this learning is the assistance teachers or educators provide to transition knowledge to students. Therefore, learning can be interpreted as an enlightenment process by teachers to help students gain learning and abilities through the learning materials

provided. This paradigm regarding the essence of learning has become classic with the COVID-19 case, which has changed the world's paradigm of learning and education (Dewi, 2020).

The variation in learning resources provided indirectly is expected to influence children's ability to receive the information provided by the teacher. One level of ability that is an indicator of the achievement of a learning process is the quality of student learning outcomes. Learning outcomes are abilities obtained by individuals after the learning process, which can provide behaviour changes in knowledge, understanding, attitudes, and skills so that students become better than before (Desy, AN, 2014). Learning outcomes will measure students' mastery of learning material. It cannot be separated from the student's willingness and opportunity to study the subject matter given to him. Students must be active and diligent in learning to get excellent and satisfying results. Students can utilize the available time to understand and learn the lessons given by the teacher. Therefore, teachers also play an essential role in the learning process by designing and implementing good learning so that the results obtained by students are also satisfactory. The level of student learning outcomes is a tool to determine whether a student is experiencing learning changes.

The learning process can be done online or offline. Offline learning is learning using a face-to-face system in class between educators and students meeting directly to convey learning information. Offline learning is also often equated with the lecture method because the learning system is still teacher centered. According to Muhammad (2020) in Isna (2021), if we look back at the obstacles and complaints regarding online learning, it is evident that the teaching profession cannot be replaced by sophisticated technology. However, due to the pandemic, offline learning cannot be carried out as it should, therefore online learning is implemented.

Online learning is all activities/activities carried out by teachers and students, students and students using internet media and online learning is also learning that is carried out without direct face-to-face contact, but through available platforms. In general, it can be said that even though the learning process is carried out online, students still get the same learning results as the offline learning process. Research conducted by Nursing et al., (2020) examined the analysis of biostatistical learning outcomes based on offline and online learning methods. This research has relevance to research conducted by researchers, namely discussing learning outcomes. However, these two studies have differences, namely that in Purnawinadi's research the subjects were students, while in this research the subjects were female students. Research conducted by Yuniarti (2021) researched differences in student learning outcomes before and during the Covid-19 pandemic in mathematics education study programs. This research has relevance to the research carried out by researchers, namely the research method used is quantitative research and data collection is carried out through documentation in the form of a list of final values. However, there is a difference in this research, namely that the previous research examined tertiary institutions while this research examined junior high schools. Based on this background, the researcher formulated the problem that will be studied, namely whether there are differences in student mathematics learning outcomes between offline and online learning at SMP Negeri 2 Palu. In line with the problem formulation, the aim to be achieved in this research is to obtain information regarding whether there are differences in student mathematics learning outcomes between offline and online learning at SMP Negeri 2 Palu.

2. METHOD

The research method used by researchers is quantitative research. Quantitative research is research used to test the relationship between variables (Sugiyono, 2018).

Meanwhile, the type of research used by researchers is comparative research. This research was carried out at SMP Negeri 2 Palu, which is located on Jalan Wolter Monginsidi No.4, North Lolu, East Palu District, Palu City, Central Sulawesi Province. This research was carried out in the even semester of the 2022/2023 academic year. The population of this research was all class VIII students at SMP Negeri 2 Palu who carried out offline and online learning in mathematics, totaling 332 students, consisting of eleven classes. The sample was class VIII students, sampling was carried out using *purposive sampling.* The students that the researchers took were students who carried out offline and online learning, with different samples but had the same academic abilities. Students who carried out offline learning were taken as many as 60 students and students who carried out online learning were taken as many as 60 students, so the total sample taken was 120 students. The data collection technique in this research is by taking the mid-semester test scores on the Pythagorean theorem material for the even semester of the 2021/2022 academic year obtained by students during online learning and the mid-semester test scores on the Pythagorean theorem material for the even semester of the 2022/2023 academic year obtained by the students. during offline learning. Provided that the material taught is the same during offline and online learning and the students being taught have the same academic abilities. The data obtained was analyzed to find out whether there were differences in student mathematics learning outcomes between offline and online learning. Before testing the data, a normality test needed to be carried out to find out whether the data used was normally distributed or not. The normality test used is the Kolmogorov Smirnov test. If the normality test results show that the data obtained is normally distributed, then proceed with the homogeneity test and then analyzed using the *Independent samples test* , whereas if the normality test results show that the data obtained is not normally distributed then the data is analyzed using the Mann-Whitney test. Apart from that, the data was also analyzed using descriptive statistics to determine the average value and standard deviation. The tests used were carried out with the help of SPSS 25.

3. RESULTS A ND DISCUSSION

3.1. Results

Researchers used mid-semester test score data on the Pythagorean theorem material for the even semester of the 2021/2022 academic year, attended by 60 students in online learning, while mid-semester test score data on the Pythagorean theorem material for the even semester of the 2022/2023 academic year were attended by 60 students in offline learning.

The following is data on the difference between the lowest and highest scores as well as the mean for mathematics subjects for the 2021/2022 academic year, the online method for the even semester and the offline method for the even semester for the 2022/2023 academic year.

Table 1. Data on differences in scores for offline and online learning.

Statistics	Offline Learning	Online learning
N	60	60
Minimum	15	32
Maximum	95	88
Mean	68.27	64.13
Std. deviation	22.29	15.71

Source: SPSS output offline and online learning data

The results of the descriptive statistics presented in table 1 show that the mean and standard deviation values for offline learning are 68.27 and 22.2 9. A standard deviation value that is smaller than the mean indicates that the data is homogeneous. From this average score, it can be concluded that the average mid-semester test score on the Pythagorean theorem material taught online in the even semester is 68.27. The minimum and maximum values for this data are 15 and 95. Meanwhile, the results of descriptive statistics for online learning, namely the mean and standard deviation values, are 64.13 and 15.71. A standard deviation value that is smaller than the mean indicates that the data is homogeneous. From this average score, it can be concluded that the average mid-semester test score on the Pythagorean theorem material taught offline in the even semester is 64.13. The minimum and maximum values of the data are 32 and 88.

Table 2. Data Normality Test Results for Offline and Online Learning

Statistics		**Offline learning**	**Online learning**
N		**6 0**	**6 0**
Normal parameters	Mean	64.13	68, 27
	Std. Deviation	1 5.71	22.27
Most Extreme Differences	Absolute	0,13	0,18
	Positive	0,07	0,12
	Negative	-0,13	-0,18
Kolmogorov-Smirnov Z		1,01	1,42
Asymp. Sig. (2-tailed)		0,255	0,125

Test the normality of mid-semester test score data on Pythagorean theorem material taught online using the *Kolmogorov-Smirnov test* presented in table 2 with a significance level of α 0.05, Asymp was obtained. Sig. (2-tailed) is worth 0.125. Meanwhile, in offline learning, Asymp. Sig. (2-tailed) has a value of 0.255 due to the Asymp value. Sig. (2-tailed) is greater than the significance level α 0.05, so it can be concluded that the online and offline learning data is normally distributed.

Table 3. Data Homogeneity Test Results in Offline and Online Learning

	Levene's Test for Equality of Variances				
	F	Sig	t	Df	Sig. (2-tailed)
Equal **Learning Outcomes** variances	5.84	.098	-1.17	118.00	0,243
Assumed **mathematics**					
Equal variances not assumed			- 1.17	118 .00	0,243

Source: SPSS output analysis data

Test the homogeneity of mid-semester test score data on the Pythagorean theorem material taught online and offline using the *independent samples test* presented in table 3 with a significance level of α 0.05, obtaining a Sig value of 0.098. Because 0.098 is greater than the significance level α 0.05, it can be concluded that the offline and online learning results data have the same or homogeneous variance.

Tabel 4. Hypothesis Test On Offline And Online Learning

	Levene's Test Equality of Variances		**T-Test for Equality of Means**			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Hasil belajar matematika Equal Variance assumed	5.84	.098	-1.17	118.00	.243	-4.13
Equal variances not assumed			-1.17	106.02	.243	-4.13

Sumber: data analisis output SPSS

Test the hypothesis of data on offline and online learning results for mathematics subjects at SMP Negeri 2 Palu using *tests independent sample test* is presented in table 4.6. with a significant level of α 0.05 obtained Sig. (2-tailed) is worth 0.243. Because 0.243 is greater than the significance level α 0.05, it can be concluded that the critical area H_0 is accepted while Ha_{is} rejected which means there is no difference in student mathematics learning outcomes between offline and online learning.

3.2. Discussion

This research was conducted to determine the differences in student mathematics learning outcomes between offline and online learning at SMP Negeri 2 Palu. Researchers conducted an analysis of the mathematics learning outcomes of class VIII students in online and offline learning.

The learning process carried out online has several obstacles that affect the learning process, as well as offline learning which has several obstacles for students. Based on the results of interviews conducted by researchers, it can be concluded that when learning online, some students still experience internet quota difficulties because students still depend on their parents to buy internet quota, and subsidies from the government have stopped when offline learning is carried out. Students also have difficulty getting high grades due to students' lack of activity in searching and studying in depth the material the teacher has presented. Meanwhile, when learning offline, many students admitted that they were hampered in getting transportation to school during offline learning because the distance from home to school was quite far and they did not have private means of transportation. Students stated that they did not understand the material and explanations from the teacher during offline learning. However, students felt there was no difference in getting high grades online or offline. Most of the research subjects also had difficulty adapting and socializing, such as asking about material or working in groups with friends during offline learning. Based on the results of the data normality test, it was found that offline and online learning had a normal distribution. After the data is normal, the data homogeneity test continues, based on the results of the data homogeneity test in offline and online learning which has the same or homogeneous variance. Because the t test requirements are met, the hypothesis test continues using the t test. Based on hypothesis testing using *the Independent sample test*, the results obtained are sig. (2-tailed) namely 0.243. Because 0.243 is greater than the significance level α 0.05, it can be concluded that there is no difference in student mathematics learning outcomes between offline and online learning at SMP Negeri 2 Palu. Learning using Google Classroom as carried out by Maskar et al., (2019) produces interesting and good findings, one of which is the increase in student activity during the learning process compared to offline learning. This is due to the absence of direct face-to-

face contact, causing some students who are usually embarrassed to ask questions in class, to be more active during the online learning process. In line with research conducted by nursing et al., (2020) which researched the analysis of biostatistics learning outcomes using offline and online learning methods with research results that there were no significant differences between offline and online learning outcomes.

Technological advances and the concept of independent learning through online learning methods allow students to be more active and freer to learn independently through online media so that the learning process during the pandemic does not have a negative impact on learning outcomes compared to learning conditions using offline or face-to-face methods after the pandemic. Of course, this online learning process must be supported by adequate related facilities and teacher resources which are no less important in carrying out this learning. This is because students and teachers are able to master technology and are used to using online applications, so that when there is a change in learning methods from offline to online it is not a big problem to adapt to the latest methods in learning. In line with research Yuniarti (2021), but with different respondents, namely students, the results of his research explain that distance education is at least as effective as traditional classroom learning. Even though the delivery of learning material is carried out virtually in online learning and face to face in offline learning because the learning methods and steps implemented are still the same, student learning outcomes in the end are not significantly different. Apart from that, because today's students are the millennial generation who are more familiar with digital technology, adapting learning during the pandemic from offline to online has become easier.

Online learning at SMP Negeri 2 Palu has the same effectiveness as offline learning. This can be seen from the results of the mid-semester test on Pythagorean theorem material for even semester for offline learning and the mid-semester test on Pythagorean theorem material for even semester for online learning which has an average difference of 3.8. The results of this research are in line with research by Ramadina et al., (2022) The results of the research explain that there is no significant difference between the mathematics learning outcomes of SMPN 3 Waru students when doing face-to-face learning and when doing online learning at the start of the pandemic. This shows that online learning at SMPN 3 Waru has the same effectiveness as face-to-face learning. Then, according to Nurfaidawati (2021), the online learning system has no influence on student learning outcomes. However, the results of this research are different from Meliniawati's (2021) research results explaining that there are differences in learning outcomes in online learning and face-to-face learning. This is because online learning carried out by teachers has not been carried out optimally.

Evaluation activities carried out in both offline and online learning require teachers to raise enthusiasm and motivate students. So that students can carry out evaluation activities optimally and obtain satisfactory learning results. Evaluation activities carried out in offline learning mean that students are given assignments in class and only given one hour so that students cannot work together with friends or be helped by anyone. Meanwhile, evaluation activities carried out in online learning mean that students are given practice assignments in the morning and then given time to work on them until 4 in the afternoon. With the free time given, students can work on assignments at home together with friends or with help from older siblings and their parents, students can also search for answers on the internet (Google). So, this is what makes students' mathematics learning outcomes during online learning better than their mathematics learning outcomes during offline learning. The results of this research are in line with the research of Pratika & Wahyuni (2022), the results of which explain that there is no difference in mathematics learning outcomes between offline and online learning at Krida Utama Gunung Sugih Middle School. This means that students' mathematics

learning outcomes during online learning are no better than students' mathematics learning outcomes when offline learning is limited.

4. CONCLUSION

From the results of the research and discussion described in the previous chapter, it can be concluded that based on hypothesis testing of student learning outcomes data between offline and online learning using the Independent Sample test, Asymp Sig results were obtained. (2-tailed) namely 0.243. Because 0.243 is greater than the significance level α 0.05, the working hypothesis (H_0) in this study is accepted, namely that there is no difference in student mathematics learning outcomes between offline and online learning at SMP Negeri 2 Palu. At the same time, (H_a) is rejected. This shows no difference in student mathematics outcomes between offline and online learning. In general, it can be said that even though the learning process is carried out online, students still get the same learning results as the offline learning process. This has given rise to the perception that the effectiveness of the online learning process, which has been a concern for so long, can still be overcome by prioritizing good process standards in online learning. This is due to the absence of direct face-to-face contact, causing some students, who are usually embarrassed to ask questions in class, to be more active during online learning. With the current situation where offline learning has been carried out again, teachers are expected to be able to rebuild students' enthusiasm for learning, as well as students' self-confidence, so that they are expected to be able to improve learning outcomes in learning that takes place at school or offline, especially in mathematics subjects.

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MATHEMATICAL COMMUNICATION ABILITY OF CLASS X MIPA 1 MAN DONGGALA STUDENTS

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ABSTRACT

This type of research is a descriptive qualitative approach. The subjects in this research are class X MIPA 1 MAN Donggala students, consisting of 4 people, each two male students and two female students, who have FI cognitive style and FD cognitive style. Written assignments and interviews obtained data on students' communication skills. The results of the research show that the mathematical communication skills of students who have a Field-dependent cognitive style are less capable than men because they cannot achieve all the indicators. The student subject has a Field Dependent female cognitive style, which is quite capable because it achieves one. The student subject has a Field Independent male cognitive style, which is quite capable because it achieves two indicators. The student subject has a Field Independent female cognitive style that is capable of achieving all three indicators. The conclusion obtained from this research is that students' mathematical communication abilities are generally said to be poor. The majority of students have not met several indicators of the three indicators of students' mathematical communication abilities. This condition can be seen with only one student achieving all three indicators.

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1. INTRODUCTION

Mathematics is an abstract science so studying mathematics requires the ability to reason. Mathematics is also a subject that must be studied at every level of education at school.Novri et al., (2018) said mathematics is one of the most important subjects in the world of

education, because mathematics lessons can help students think logically, rationally, critically and broadly, this is in line with the goals of national education, namely: preparing students to be able to face changes in the world which is always changing, acts on the basis of logical, rational, critical thinking, and so that students are able to use mathematics in everyday life and in studying various sciences. Mathematics is also used as a language, which requires communication to convey mathematical ideas or ideas such as symbols, letters and others.

In daily activities, a person cannot be separated from communication. Communication can take place between individuals, groups, social groups and so on, communication is the delivery of messages verbally and in writing between people.Basic communication skills in general include oral and written abilities. Oral abilities are in terms of pronunciation, understanding, listening, while written abilities are practice writing letter symbols, reading symbols, practice using words or punctuation, and so on. Lamonta et al., (2016) states that mathematical communication is a student's ability to convey something they know through dialogue events or what occurs in the classroom environment, so that message transfer occurs. The transferred message can contain mathematics material that students are studying, for example concepts, formulas, or strategies for solving a problem. These messages are the result of mathematical communication which is important in the process of organizing thoughts, developing patterns, connecting ideas with other ideas so that they can improve students' understanding of mathematical concepts.

Communication is a very important component in the mathematics learning process. The abstract characteristics of mathematics result in many students simply swallowing all the material without trying to understand what information it contains. Most students apply the method of memorizing formulas to learn mathematics, even though the basis of learning mathematics is not memorization but as stated in the fourth point of mathematics learning objectives listed in National Education Minister Regulation number 22 of 2006 is for students to be able to communicate ideas using symbols, tables, diagrams or other media. to clarify a situation or problem. Thus, it is clear that mathematical communication is an important ability that needs to be developed in every student.

According toPratiwi et al., (2013) said that one of the things that influences students' mathematical communication skills in solving problems is cognitive style. Cognitive style influences mathematical communication abilities both in presenting written ideas and communicating ideas verbally, so researchers will examine mathematical communication abilities in terms of cognitive style. Cognitive style is a person's style or characteristics in receiving, storing, processing, making decisions, presenting information and responding to a task or various types of environmental situations. The position of cognitive style in the learning process cannot be ignored. This is in line with this viewWicaksana & Rachman, (2018)Saying that cognitive style is one of the student characteristics that is included in the learning conditions variable, in addition to other student characteristics such as motivation, attitude, talent, interest, thinking ability, etc.

Imanita et al., (2021) say thatThere are many variations in cognitive styles that are of interest to educators and they differentiate cognitive styles based on dimensions: (a) differences in psychological aspects, which consist of field dependent (FD) and field independent (FI), (b) time to understand concepts, which consist of impulsive styles. and reflective style.According to him, implementation in learning really determines learning so researchers want to review the cognitive styles of FI and FD.A student who has the FI cognitive style looks at things analytically or sets boundaries in analyzing patterns, is able to distinguish objects around him and tends not to be easily influenced by the environment, while the FD cognitive style looks at things globally, not able to distinguish objects around

them and tend to be more easily influenced by the environment.

Based on the results of interviews conducted by researchers with one of the mathematics teachers on Monday, 22 August 2022 at MAN Donggala, information was obtained that there were still many students who had difficulty working on questions, namely changing verbal language into mathematical models and writing mathematical symbols.There are still many students in the class who are less enthusiasticin expressing his mathematical ideas when the student is asked to explain the answer he has worked on, the student is still hesitant in answering, it can besaid The student understands the material that has been taughtgivenif students can express or communicate their mathematical ideas verbally and in writing well. It is very important for students to have mathematical communication skills orally and in writing so that teachers can find out students' understanding. So this is the basis for researchers to profile students' mathematical communication abilities. SPLTV material was chosen in order to explore students' mathematical communication skills because many problems related to everyday life can be worked on with SPLTV material expressed in mathematical communication.

The low mathematical abilities of students in Indonesia can also be seenbased on the results of the Program for International Students study*Assessment* (PISA) 2018 which was released on Tuesday, December 3 2019. Based on the results of this study, Indonesia's 2018 PISA ranking decreased when compared to the 2015 PISA results. This 2018 study assessed 600,000 15 year old children from 79 countries every three years. The study compared math, reading, and science performancefrom each child (Tohir, 2019). Based on the results of interviews conducted by researchers at MAN Donggala, students' mathematical abilities are also low. It can be seen from the exam results that many students scored below the completion standard. Based on the problems experienced by students, teachers must be aware of the different types of students for each individual. Identifying student types in terms of cognitive style will help teachers provide appropriate treatment for students' mathematical communication ability problems.

Based on a preliminary study conducted by Pane (2018), regarding the analysis of students' mathematical communication skills in data presentation material in class VII MTs Islamiyah Medan. The conclusion obtained from this research is that students' mathematical communication abilities are generally said to be poor, this is because the majority of students have not met several indicators of the five indicators of students' mathematical communication abilities, whereas research conducted by Ridwanah, RM, & Masriyah, M. (2021) shows that field dependent and field independent cognitive styles can influence students' written communication in problem solving. Therefore, it is important for teachers and students to know written mathematical communication in order to improve abilities and understanding in problem solving.Based on the background that has been described, it is necessary to carry out research to determine the description of students' mathematical abilities for cognitive learning styles, so that they can form appropriate actions to optimize mathematical communication abilities. Based on the background of the researcher, he was interested in conducting research with the title "AbilityStudent Mathematical CommunicationClass X MIPAin Completing SPLTV Viewed from Cognitive Style"

2. METHOD

This type of research is descriptive research with the approach used, namely a qualitative approach.This research was carried out at MAN Donggala which is located on the Trans Sulawesi road, Surumana, South Banawa District, Donggala Regency, Palu City, Central Sulawesi Province. This research was carried out in the even

semester of the 2022/2023 academic year.

The subjects in this research were class Subject selection is done by providing*Instrument Group Embedded Figure Test*namely finding a simple shape hidden in a complicated image with 18 questions. After that, FD and FI cognitive styles were classified based on the GEFT score. The correct answer will be given a score of 1 and the wrong answer will be given a score of 0. The subjects taken are students who have FD and FI cognitive styles with the following classification:

1. Students with a score ≤ 9 include students with the FD cognitive style
2. Students with a score > 9 include students with the FI cognitive style

For the classification of cognitive styles, 2 subjects with FD cognitive style were taken, namely students who had the lowest scores, with 1 female subject with FD cognitive style and 1 male subject with FD cognitive style and 2 subjects with FI cognitive style, namely students who had The highest score was 1 female subject with FI cognitive style and 1 male subject with FI cognitive style so 4 subjects were selected.

For students' mathematical communication skills, the material used is a system of three variable equations (SPLTV). This research instrument uses written assignments and in-depth interviews with research subjects. The indicators used areMathematical communication skills adapted fromseveral opinions, then there are 3 indicators of students' mathematical communication abilities in this research, namely:

1. Students' ability to express everyday events in the form of language or mathematical sentences. In this research, students can use symbols when writing down all the information, questions are contained in questions that are made in the form of mathematical models when solving problems.
2. Ability to understand, interpret and evaluate mathematical ideas both orally, in writing and in other visual forms.

In this research students can understand, explain and writefrom a mathematical problem with mathematical steps so as to obtain a solution or answer to the problem mathematically and be able to calculate the problem properly and correctly.

Students' ability to summarize answers verbally and in writing. In this research, students can write conclusions from the SPLTV solutions provided using their own language.

3. RESULTS AND DISCUSSION

3.1. Results

Research subjects were obtained by grouping students based on cognitive style and gender, namelyField Dependent cognitive style and Field Independent cognitive style, gender, namely male and female. Results of cognitive style grouping of 22 students.

Table 1. Cognitive Style Test Results

Cognitive style	Gender	Amount
Dependent Fields	Man	2
Dependent Fields	Woman	6
Field Independent	Man	4
Field Independent	Woman	10

Data was obtained that as many as 2 students had a male Field Dependent cognitive style, as many as 6 students had a female Field Dependent cognitive Style, as many as 4

students had a Female Field Dependent Cognitive Style. Field Independent cognitive style is male, and as many as 10 students have Field Independent cognitive style female gender, then 4 subjects are selected from the cognitive style, male and female gender, in the selection to discuss with the field of study teacher.In Table 2 the subjects are presentedcognitive styles of male Field Dependent, female Field Dependent, male Field Independent, and female Field Independent.

Table 2. Research Subjects

Subject Name Initials	Subject Code	Score
AN	FDL	9
IN	FDP	9
AB	FIL	15
NA	FIP	16

Following exposure student data has a male Field Dependent cognitive style

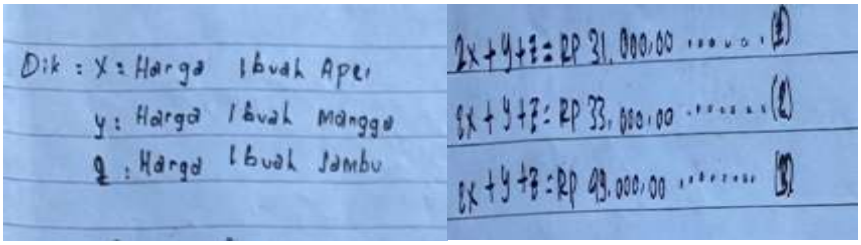

Figure 1 FDL Subject's Answers to Indicator 1

Based on the explanation of the answers and interview results, FDL was unable to write down all the known information using symbols formed in a mathematical model. FDL made a mistake in writing the separation (figure 1), then FDL was unable to reveal the use of colons in the separation. FDL was also unable to express how to write the written symbols and FDL did not write down what was asked in the problem but he was able to express the question in the problem by looking at the question mark at the end of the sentence but he forgot to write it.

Figure 2 FDL Subject's Answers to Indicator II

Based on the explanation of the answers and interview results, FDL was wrong in solving the problem, even though the arithmetic operations used were correct, but FDL was wrong in calculating the results of the answer, FDL was unable to explain the answer to the solution of the steps according to the answer he had written and was unable to express the reasons. using arithmetic operations. FDL was unable to mention and explain

the method used to solve the problem, then when explaining the steps to solve it, FDL realized that the solution answer he had worked on was wrong in calculating the answer in the elimination step so that the calculation results were not correct.

Based on the presentation of FDL's answers and interview results, the description was that FDL did not write down the conclusions of his answers, and FDL could not verbally express the conclusions of the answers he obtained because FDL no longer knew the next step in solving the problem so FDL could not write down the answer conclusions.

The following is a presentation of data on students who have a Female Field Dependent cognitive style:

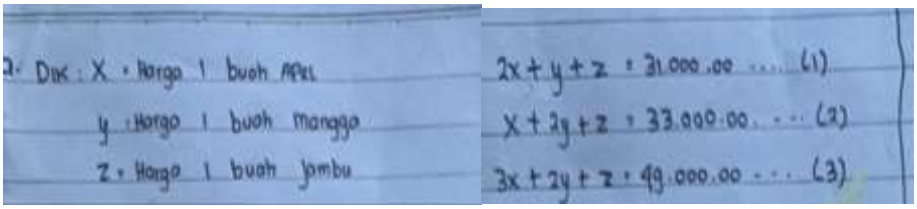

Figure 3. FDP Subject Answers to Indicator I

Based on the explanation of the answers and interview results, FDP wrote down and conveyed all known information using symbols formed in a mathematical model by first analyzing the problem (Figure 3). Then FDP can reveal the use of colons in the example x is the price of an apple. FDP is unable to express how to express the written symbols and FDP does not write down what is asked in the question but FDP can express the question in the problem by looking at the question mark at the end of the sentence but FDP forgets to write it.

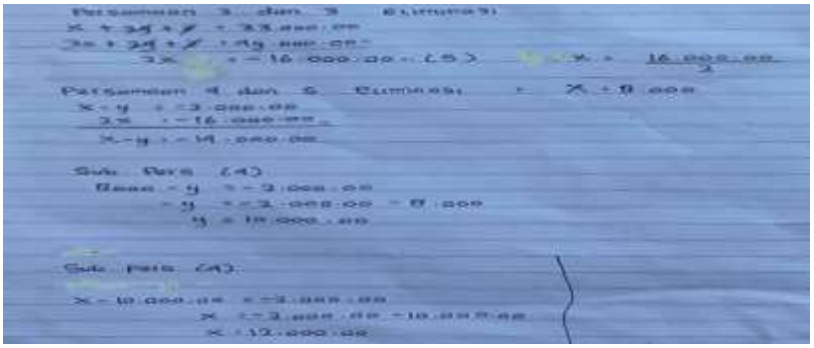

Figure 4. Answers of FDP Subjects in Indicator II

Based on the explanation of the answers and interview results, FDP was wrong in solving the problem even though he had used the elimination and substitution method correctly (Figure 4), but in the step of solving the substitution equation 4, FDP was wrong in determining the value of x, he looked for the answer to the value of x twice, he should have looking for the z value, then FDP was able to explain again the solution to the steps according to the answers he had written, then FDP realized his mistake by looking for the x value twice so that FDP could not solve the problem. FDP was also only able to mention the method used to solve the problem but was unable to explain because FDP had forgotten how to do it.

Based on the explanation of the answers and the results of the interview, a description was obtained that FDP did not write down the conclusions of his answers, and FDP could not verbally express the conclusions of the answers obtained because FDP made a mistake in solving the questions so he did not get a conclusion.

The following is a presentation of data on students who have a male Field Independent cognitive style:

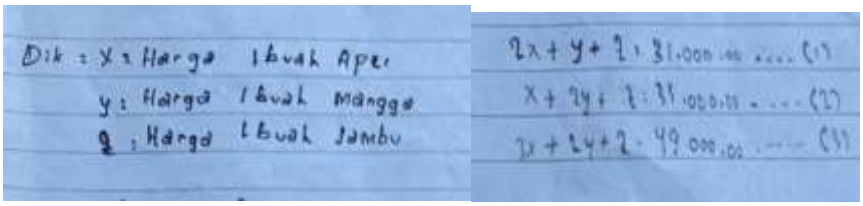

Figure 5. FIL Subject's Answers to Indicator I

Based on the explanation of the answers and interview results, FIL wrote down all the known information using symbols formed in a mathematical model by making examples first. FIL was able to express how to express the written symbols, but FIL did not write down what was asked in the question, but FIL was able to express it.

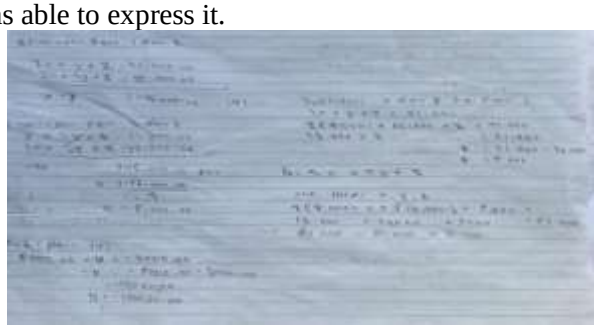

Figure.6. FIL Subject's Answers to Indicator II

Based on the presentation of answers and interview results, FIL can solve problems correctly by using the elimination and substitution method, FIL is also able to explain the answers to solve the steps according to the answers he has written, FIL is able to mention and explain the methods used to solve the problem. according to his understanding. FIL is also able to evaluate the solution answers that have been worked out to ensure that the answers that have been worked out are correct.

Based on the presentation of FIL's answers and interview results, a description was obtained that FIL could express the conclusions of his answers verbally, but FIL did not write the conclusions of his answers using his own language because FIL forgot to write them down.

The following is a presentation of data on students who have a female Field Independent cognitive style:

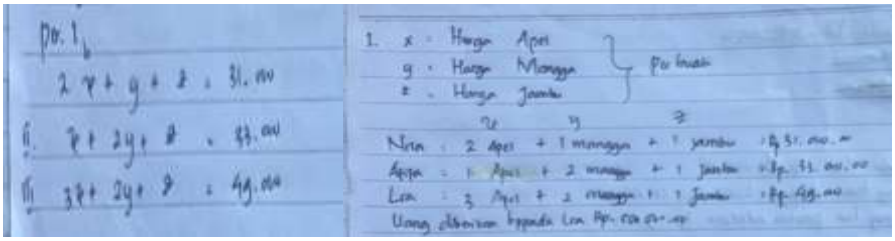

Figure 7. FIP Subject Answers to Indicator I

Based on the explanation of the answers and interview results, FIP wrote down all the known information using symbols in the form of a mathematical model by making examples first. FIP was able to express how to express the written symbols, but FIP did not write down what was asked in the question, but he was able to express it.

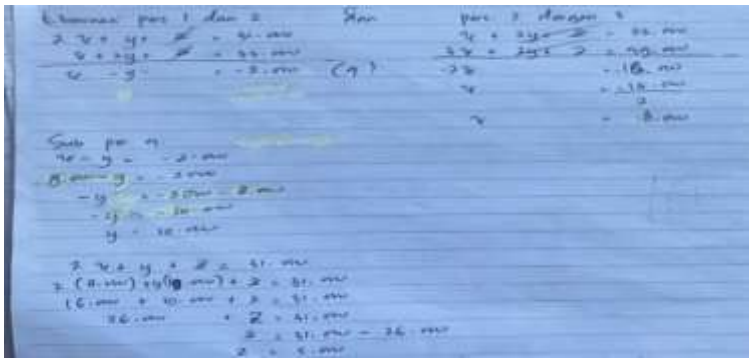

Figure 8. FIP Subject Answers to Indicator II

Based on the explanation of the answers and interview results, FIP was able to solve the problem correctly using the elimination and substitution method. FIP was also able to explain the answer to the solution of the steps according to the answer he had written. FIL is able to mention and explain the methods used to solve problems. FIP is also able to evaluate the solution answers he has worked on to ensure that the answers he has worked on are correct.

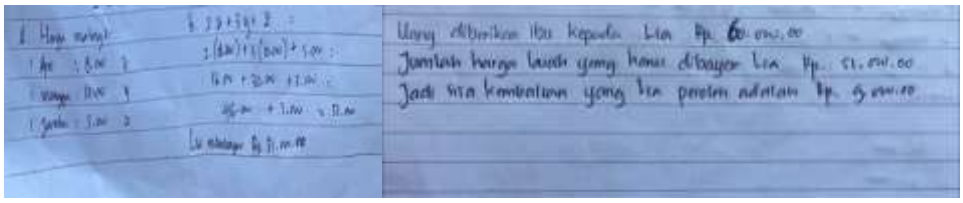

Figure 9. FIP Subject Answers to Indicator III

Based on the presentation of FIP's answers and interview results, a description was obtained that FIP could express conclusions from the answers verbally that he obtained, and FIP could write conclusions from his answers completely using his own language (figure 9).

3.2. Discussion

a. Profile of mathematical communication abilities of FDL subjects

In indicator I mathematical communication skills,FDL is not able to write all known information using symbols formed in a mathematical model because it is wrongwrite an example. FDL is also unable to express how to write the written symbols and FDL does not write down what is asked in the problem but he is able to express the question in the problem but he forgets to write it down, so FDL is unable to express everyday events in the form of language or mathematical sentences.

In indicator II mathematical communication skills,FDL was unable to understand the steps to solve the problem because FDL was wrong in solving the problem even though the calculation operations used were correct, but FDL was wrong in calculating the results of the answer. FDL is unable to explain the answer to the completion of the steps according to the answer and cannot express the reasons for using arithmetic operations. FDL is unable to mention and explain the methods used to solve problems. FDL was only able to evaluate the solution answers that he had worked on. It turned out that he was wrong in calculating the answers in the elimination step so that the calculation results were not correct. This is in line with opinionRidwanah, RM, & Masriyah, M. (2021)in the implementation stage of the settlement, SFD wrote down

the calculation stages inaccurately, completely, and not smoothly, sSo FDL is not able to enterunderstand, interpret and evaluate mathematical ideas either verbally, in writing or in other visual forms.

In indicator III of mathematical communication ability, FDL cannot
Write the conclusion of the answer at the end of solving the problem. So, FDL does not capablesummarize the results of the answers orally and in writing.

b. FDP subject's mathematical communication ability profile

In indicator I of mathematical communication ability, FDP is able to write and convey all known information using symbols formed in a mathematical model by making examples first. This is in line with the opinion of Safira (2019). Field Dependent (FD) subjects are able to make examples for values that have not yet been determined. known into certain variables. Then the subject arranges them into a mathematical model. Then FDP can reveal the use of colons in the example where x is the price of an apple, p. FDP is unable to express how to express the written symbols and FDP does not write down what is asked in the problem but he can express the question in the problem but he forgets to write it, so FDP is able to express everyday events in the form of language or mathematical sentences.

In indicator II of mathematical communication skills, FDP Based on the explanation of the answers and interview results, FDP was unable to understand the steps for solving the problem, that FDP was wrong in solving the problem in determining the x value, he looked for the answer to the x value twice, but FDL was able to explain the solution again from the steps according to the answers he has written in a structured manner. FDP is unable to explain the methods used to solve the problem. FDP is also able to evaluate solution answers, but FDP cannot solve the problem correctly, so FDP is unable to solve problemsunderstand, interpret and evaluate mathematical ideas either verbally, in writing or in other visual forms.

In indicator III of mathematical communication ability, FDP cannot write down and cannot explain the answer conclusions at the end of completing the questions, so FDP is unable to conclude the results of the answers verbally or in writing.

c. Profile of mathematical communication abilities of FIL subjects

In indicator I mathematical communication skills,FIL is able to write all known information using symbols in the form of a mathematical model, FIL is able to express how to express the written symbols. But FIL did not write down what was asked in the question but he was able to express it but he forgot to write it down, so FIL was able to express everyday events in the form of language or mathematical sentences.

In indicator II mathematical communication skills,FIL is able to understand the steps to solve the problem, FIL is also able to explain the answers to the solution of the steps according to the answers he has written. FIL is able to explain the methods used to solve problems. FIL is also able to evaluate the solution answers he has worked on to ensure that the answers he has worked on are correct. This is in line with opinionRidwanah, RM, & Masriyah, M. (2021)SFI writes down the calculation stages accurately, completely and smoothly, then at the re-checking stage, the conclusions are written accurately, completely and smoothly,so FIL is able to deepunderstand, interpret and evaluate mathematical ideas either verbally, in writing or in other visual forms.

In indicator III mathematical communication ability,FIL nowrite it down because you forgot to write it down.However, you can explain the answer conclusions at the end of solving the questions, so that FIL is unable to conclude the results of the answers in writing.

d. Profile of mathematical communication abilities of FIP subjects

In indicator I mathematical communication ability, FIPable to write all known information using symbols in the form of a mathematical model, FIP is able to express how to express the written symbols, but FIP does not write down what is asked in the question but he is able to express it but he forgets to write it down, so FIP is able to express everyday events in form of language or mathematical sentences.

In indicator II mathematical communication skills,FIP is able to understandproblem solving steps, FIP is also able to explain the answers to the solutions of the steps in accordance with the answers he has written. This is in line with the opinion of Pane (2019) which states that the abilityinterpreting mathematical ideas both in writing and in other visual forms, which can be seen when students can write down the concept of the formula that will be used in solving the problem accompanied by the correct steps and correct calculations. FIP is able to explain the methods used to solve problems. FIP is also able to evaluate the solution answers that he has worked on to ensure that the answers he has worked on are correct by checking the results of his answers again, so that FIP is able tounderstand, interpret and evaluate mathematical ideas either verbally, in writing or in other visual forms.

In indicator III of mathematical communication skills, FIP can write down and explain the conclusion of the answer at the end of solving the problem, so that FIP is able to conclude the results of the answer orally and in writing.

4. CONCLUSION

Based on the results of the research and discussion that the researcher has presented, it was concluded that students' mathematical communication abilities have a Field Dependent cognitive style. Men are less capable because they cannot achieve all the indicators. The student subject has a Field Dependent cognitive style, women are quite capable because they achieve one. The student subject has a Field Independent male cognitive style which is quite capable because it achieves two indicators. The student subject has a Field Independent female cognitive style that is capable of achieving all three indicators. So the conclusion obtained from this research is that students' mathematical communication abilities are generally said to be poor, this is because the majority of students have not met several indicators of the three indicators of students' mathematical communication abilities, only one student has achieved all three indicators.

SUGGESTION

In learning activities, teachers can provide story questions related to daily life that are linked to the material that has been taught to improve students' mathematical communication skills. It is hoped that further research will be carried out regarding the learning process with certain models that can improve students' mathematical communication skills.

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PROFILE OF STUDENT'S CONCEPT UNDERSTANDING IN COMPARATIVE MATERIAL WITH VALUE AND VARIOUS GRADES IN CLASS VII

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ABSTRACT

Students' understanding of concepts needs to be profiled so that teachers can find out the description and understanding of students' mathematical conceptsThis study aims to obtain a description or description of students' understanding of the concept of value comparison material and value turning at SMP Negeri 1 Ampibabo. This type of research is descriptive with a qualitative approach. The subjects of this study were students of class VII A at SMP Negeri 1 Ampibabo, which consisted of one student each with high, medium, and low mathematical abilities and good communication skills according to the teacher's recommendations. The results of this study are that students with high mathematical abilities are able to use the four indicators to understand the concept, and students with moderate mathematical abilities are able to use the four indicators to understand the concept. However, they are still mistaken in distinguishing comparisons of equivalent and reverse values, and students with low mathematical abilities are only able to use three indicators of conceptual understanding in working on comparison questions of value and return value.

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1. INTRODUCTION

Mathematics is an important science in shaping attitudes, a person's ability to hone logic and thinking, and can direct a person in finding solutions to problems related to everyday life. Learning Mathematics requires that each student understands mathematical concepts which include the ability to explain relationships or linkages between concepts and utilize and apply a concept easily and precisely without losing the true meaning of a concept in problem solving (Kemendikbud, 2017).

Understanding mathematical concepts is a basic thing that must be possessed by a student because a good understanding can help students' procedural abilities in solving a mathematical problem (Asri et al., 2020). According to Riyandiarto in (Purwaningsih et al., 2017) conceptual understanding is very important in learning mathematics so students need to master understanding mathematical concepts because in learning mathematics consists of several interconnected concepts. However, at this time, many students have difficulty understanding mathematical concepts. As expressed by Russefendi in (Asri et al., 2020) there are some students who have studied mathematics, but cannot understand even the simplest concepts. So that many students think that learning mathematics is a difficult and complicated subject.

One of the mathematical concepts learned in class VII at the SMP/MTs level is comparison. Even so, understanding the concept of comparison by students still often gets difficulties in the learning process. This is in line with the statement of (Kumalasari et al., 2013) which states that students who experience difficulties in learning mathematics are due to a lack of understanding of concepts and principles in mathematics. Based on the results of interviews with the mathematics teacher at Ampibabo 1 Public Middle School on February 17 2022, information was obtained that students had difficulty distinguishing which were equivalent comparison problems and inverse comparison problems, students made mistakes in making or translating questions in mathematical modeling, namely in determine the units involved and the value of changes between units, and students make mistakes in the calculation steps.

There is an indicator of understanding the concept based on the Regulation of the Director General of Basic Education No. 506/C/PP/2004 in (Maulida et al., 2017). In this study, 4 indicators of understanding the concept were used, namely 1) restating a concept, 2) identifying objects according to certain characteristics, 3) giving examples and non-examples of a concept, 4) using, utilizing and selecting procedures or operations certain. Understanding of concepts can be influenced by several things, one of which is students' mathematical abilities. This is in accordance with the results of research by (Gani et al., 2020) which revealed that students have different abilities in understanding a mathematical concept. Therefore, it is very important for a teacher to know the ability of each student to understand the concepts being taught.

Based on the description above, the researcher is interested in conducting further research related to students' understanding of concepts based on students' mathematical abilities with the title "Student Conceptual Understanding Profiles on Material Comparison of Values and Returns of Values in Class VII of SMP Negeri 1 Ampibabo". The purpose of this research is to describe students' understanding of concepts in material comparisons of value and return value.

2. METHOD

The type of research used by researchers is qualitative research. The approach used in this research is a qualitative descriptive approach, namely describing the profiles of students' conceptual understanding with high, moderate and low abilities in material

comparisons of value and return values. This research was conducted at Ampibabo 1 Public Middle School, located in North Ampibabo Village, Parigi Moutong Regency, Central Sulawesi, in the even semester of the 2022/2023 academic year. The selection of subjects in this study were students of class VII A of SMP Negeri 1 Ampibabo consisting of 1 subject with high ability, 1 subject with moderate ability, and 1 subject with low ability. The selection of subjects in this study was carried out by looking at the results of student semester exams in the odd semester of the 2022/2023 school year and recommendations from the teacher. Next, classify the level of students' mathematical ability in the high, medium, and low ability groups based on the student semester exam scores in the odd semester of the 2022/2023 school year. Data collection techniques in this study were carried out using interview methods and written assignments consisting of 2 story problem numbers. This study uses time triangulation to test the credibility of the data. After conducting the data credibility test, the data were analyzed using qualitative data analysis techniques according to Miles, Huberman, and Saldana (2014) carried out interactively through the Data Condensation process by focusing on the selection of research objectives, then at the data presentation stage, presented the results of condensation and After that, conclusions are drawn/verified.

3. RESULTS AND DISCUSSION

The results of grouping the data on student odd semester test results are grouped based on the grouping of (Sudijono, 2014). Subject grouping in terms of mathematical abilities, obtained 5 students with high mathematical abilities, 18 students with moderate mathematical abilities and 3 students with low mathematical abilities. Of the three levels of mathematical ability, one student was selected each, SS for students with high abilities, AF for students with moderate abilities and R for students with low mathematical abilities. The following is a description of the data on answers to written assignments and interviews for each subject.

3.1 Subjects with High Mathematics Ability SS

3.1.1 Restating a Concept

Research on SS subjects in expressing a concept was carried out by interviewing. The following is the result of the SS subject's interview in restating the concept of comparison of value and return of value.

SSM1 S1-006 S : *{-} an equivalent comparison is a comparison of two quantities, if one of the values increases/decreases then the value of the other quantity also increases/decreases{-}, and the ratio of inverse values is the comparison of two quantities, if one of the quantities increases/decreases, the other quantity decreases/increases {-}.*

Based on the interview transcript of SS at M1 in restating the concept of comparison of equivalent and reverse value based on its characteristics by providing an explanation of comparison of value is a comparison of two quantities, if one of the magnitudes increases the value of the other magnitude also increases and vice versa, a comparison of reversed values is a comparison of two quantities, When one of the quantities increases, the other decreases and vice versa. SS is also able to express the equivalent comparison equation is $\frac{a_1}{a_2} = \frac{b_1}{b_2}$ and the reverse value comparison equation is $\frac{a_1}{a_2} = \frac{b_1}{b_2}$. So it can be concluded that subjects with high mathematical ability SS are able to restate the concept of comparison of worth and value by using their own words appropriately. This is in accordance with the

opinion of (Jhonson, 1998) which states that understanding is the ability to explain a concept that has been learned using language or one's own words.

3.1.2 Identifying the Objects a Concept

Research on SS subjects in identifying comparisons of value and return values contained in question number 1 was carried out by means of written assignments and interviews. Following are the results of the SS written assignment answers in identifying comparisons of value and reverse value.

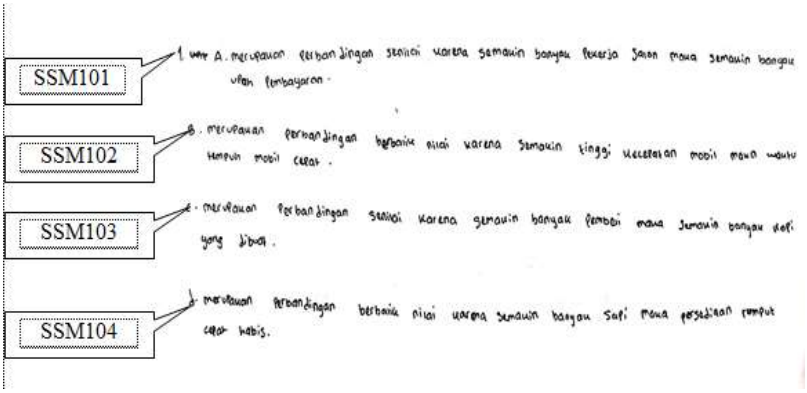

Figure 1 SS's answer in identifying comparisons of value and return value

The following are the results of the researcher's interview with the SS subject

SSM1 S1-024 S : *The number of salon workers with paid wages issued by the salon and the number of buyers with coffee provided at the coffee shop is a comparison worth whilethe speed of a car with the travel time and the number of cows with the length of the grass supplyis a reverse comparison of the value {-}*

Based on the interview transcripts, it is known that SS classifies statements that include comparisons of value, namely the number of salon workers with wages paid by the salon and the number of buyers with coffee provided at the coffee shop, while statements that include comparisons of inverse values, namely the speed of a car with travel time and the number of cows with long supply of grass. SS also revealed the reasons why the number of salon workers with paid wages issued by the salon and the number of buyers with coffee provided at the coffee shop is a comparison of value, the speed of a car with travel time and the number of cows with the duration of grass supply is a ratio of inverse value. So it can be concluded that subjects with high mathematical ability SS are able to identify comparisons of value and return value according to the characteristics of the comparison of value and return value correctly. This is in line with the results of research conducted by (Saputra, 2021) which stated that subjects with high mathematical abilities were able to solve questions identifying comparisons of value and return value.

3.1.3 Give examples and non-examples of a concept

Research on SS subjects in providing examples and non-examples of value comparisons and comparisons of value returns was carried out by interviews.

SSM1 S1-038 S : An example of a comparison worth {-}**pool water volume with pool water filling time** and which is not a comparison worth {-}**water discharge with pond water filling time** {-}

Based on the interview transcripts, it is known that SS revealed an example of a comparison of the value of the volume of pool water with the time it was filled with pool water and not an example of a comparison of value, namely the water discharge with the time it was filled with pool water accompanied by the right reasons. SS also discloses an example of a comparison of inverse values, namely the water debit with the time it takes to fill the pool and not an example of a comparison of inverse values, namely the volume of pond water and the time it is filled with the pool accompanied by the right reasons. So it can be concluded that subjects with high mathematical ability SS are able to provide examples and non-examples of comparisons of equivalent and reversed values according to their definitions correctly. This is different from the results of research conducted by (Fajar et al., 2019) which stated that subjects with high mathematical abilities were less able to provide examples and non-examples of a concept.

3.1.4 Using, Utylizing and Selecting Certain Procedures or Operations

Research on SS subjects in using, utilizing, and choosing the right procedures in solving problems of value comparisons and comparisons of value returns was carried out by means of written assignments.

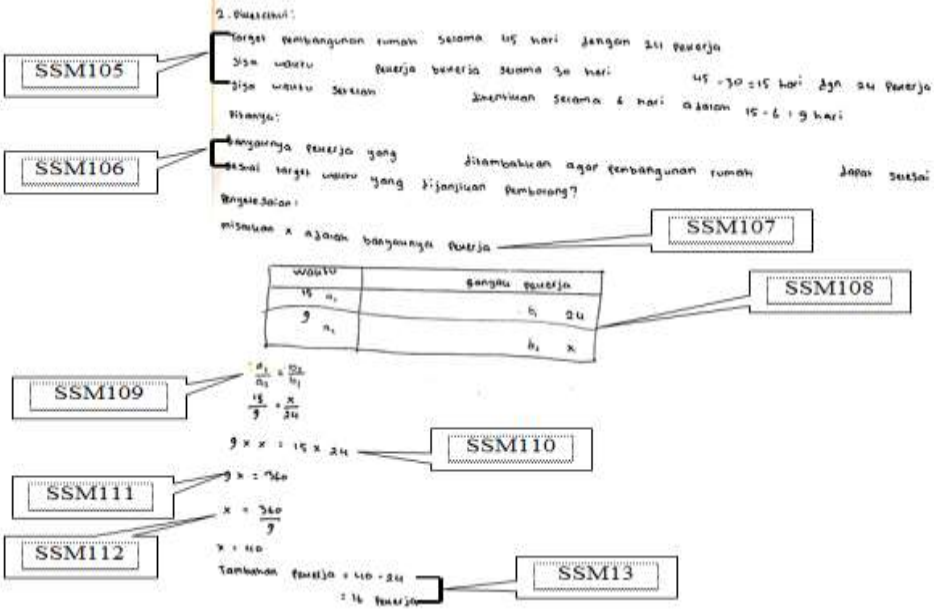

Figure 2 SS's answer uses, utilizes, and chooses the right procedure in solving the problem of comparison of equal and reverse values of Problem Number 2 Part a

The following is the result of the researcher's interview with the SS subject.

SSM1 S2-060 S : Because the question {-} is included**reverse value comparison.**

SSM1 S2-062 S : The first step {-} I write first**is known**from the problem, namely the construction target of the house promised by the contractor for 45 days with 24 workers. After that, {-} the remaining time after working for 30 consecutive days is 15 days. Because the work was stopped for 6 days because there were running out of building materials, the remaining time was 9 days {-}

SSM1 S2-064 S : {-} **asked**in terms of the number of workers that must be added so that the construction of the house is completed according to the time target promised by the contractor {-}

SSM1 S2-070 S : {-} **using** the concept of inverse comparison of values $\frac{a_1}{a_2} = \frac{b_2}{b_1}${-} **I entered the values** a_1, a_2, b_1, **and** b_2 to get the equation 15/9=x/24 **then I cross-multiplied** {-} I got 9×x=15×24, then I multiplied the result 9x=360 {-} to find the x value {-} **I divided** 360 by 9 ($\frac{360}{9}$) the result was 40 {-} After that, for To find the number of additional workers, I subtracted the number of workers obtained earlier from the initial number of workers (40-24). So the number of additional workers is 16 workers {-}

Next, an explanation of the results of the written assignment and SS interview on M1 question number 2 part b. Following are the answers to the results of SS's written assignment.

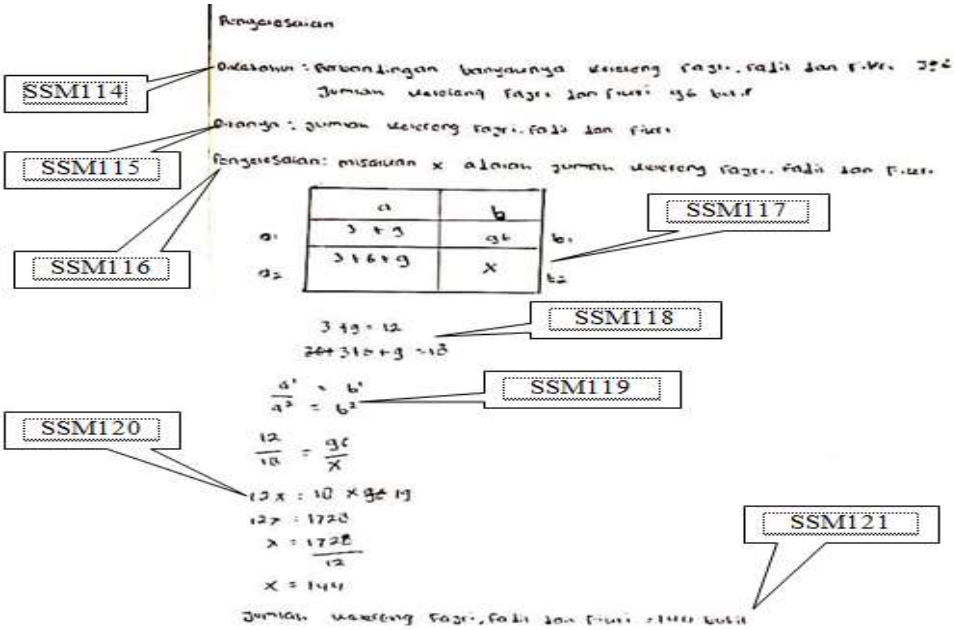

Figure 3SS's answer uses, utilizes, and chooses the right procedure in solving the problem of comparing equal and reverse values of Problem Number 2 Part b

The following is the result of the researcher's interview with the SS subject.

SSM1 S2-076 S : {--} the first one**is known** {-} the ratio of the number of marbles of Fajri, Fadil and Fikri is 3:6:9, meaning that there are 3 marbles owned by Fajri, 6 marbles owned by Fadil and 9 marbles owned by Fikri and the total marbles of Fajri and Fikri are 96 marbles. {-}**asked** {-} the number of marbles of Fajri, Fadil and Fikri.

SSM1 S2-078 S : **I let x be the number of marbles for Fajri, Fadil and Fikri** {-} then **I made a table**. For the value of a_1, I get 12, a_2 is 18, then for b_1 it is 96 and b_2 is x {-}

SSM1 S2-082 S : Next {-} **I entered these values** into the equation $\frac{a_1}{a_2} = \frac{b_1}{b_2}$, **to find the value of x** and I got that $\frac{12}{18} = \frac{96}{x}$, after that I crossed { -} I got 12x=96×18 and the result was 12x=1728. Then to **get the x value I divided** 1728 by 12, I got the result 144.

In accordance with the data on the results of written assignments and the results of interviews with subjects with high mathematical ability SS in using, utilizing, and choosing the right procedures to solve the problem of comparison of equivalent and reverse values, namely writing down what is known and what is asked, then making a mathematical model and making tables. This is in accordance with the opinion of which states that subjects with high mathematical abilities can easily state things that are known and asked and then write them down in the form of a mathematical model. After that, SS uses a reversed comparison equation $\frac{a_1}{a_2} = \frac{b_2}{b_1}$ to solve part (a) and SS uses an equivalent comparison equation $\frac{a_1}{a_2} = \frac{b_1}{b_2}$ to solve part (b) by entering values a_1, a_2, b_1, and b_2 as well as utilizing the cross-multiply operation and selecting the dividing operation accompanied by steps for solving complete and correct. So it can be concluded that the subject with high mathematical ability SS is able to use, utilize and choose the right procedure to solve the problem of comparing values and turning values. In line with the opinion of (Sa'adah, 2018) revealed that students with high mathematical abilities are able to choose and use the correct problem-solving steps to calculate with the right answer.

3.2 Subjects with Moderate Mathematics Ability AF

3.2.1 Restating a Concept

Research on AF subjects in expressing a concept was carried out by interviews. The following are the results of the researcher's interview with the AF subject.

AFM1 S1-006 S : {-} **when two quantities are compared, if one of the quantities increases, the value of the other quantity also increases, that is an equivalent comparison** and**when two quantities are compared, if one of the quantities increases, the other quantity decreases, the comparison reverses in value** {-}

Based on the AF interview transcript in restating the concept of comparison of equivalent and reversed value by providing an explanation that a comparison of equivalent is when two quantities are compared, and if one of the magnitudes increases, the value of the other quantity also increases, and the comparison of equivalent is when two quantities are compared, and if one quantity increases, the other quantity decreases. AF also states that the equivalent comparison equation is $\frac{a_1}{a_2} = \frac{b_1}{b_2}$.. So it can be concluded that the subject with moderate mathematical ability AF is able to restate the concept of comparison of worth and value based on their characteristics by using their own sentences correctly. In accordance with Carin's opinion in (Susanto, 2013) understanding is the ability to translate a concept, meaning that someone is able to understand and is able to explain back what has been learned in their own sentences.

3.2.2 Identifying the Objects a Concept

Research on AF subjects in identifying comparison objects of value and return values contained in question number 1 was carried out by means of written assignments and interviews. Following are the results of the AF subject's written assignment answers.

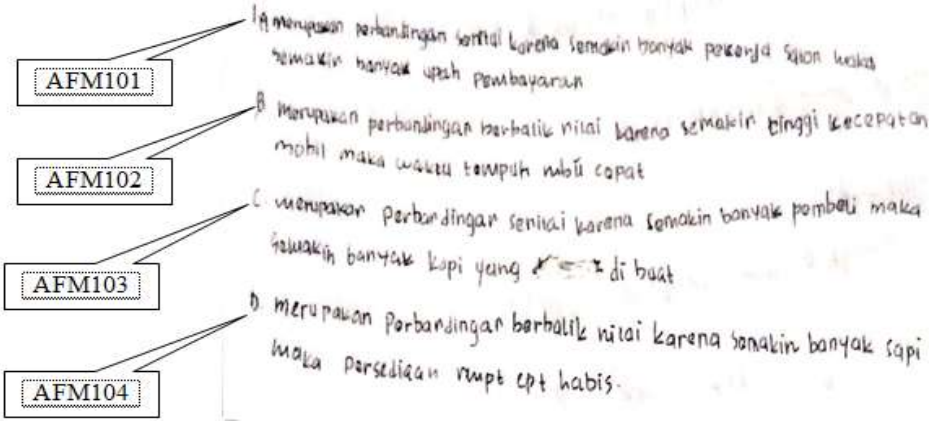

Figure 4 AF's answer in identifying a comparison of worth and turn around value

The following are the results of the researcher's interview with subject AF.

AFM1 S1-024 S : Which includes a comparison worth {-}**the number of salon workers and payment wages issued by the salon and the number of buyers with coffee provided at the coffee shop**whereas**the speed of a car with the travel time and the number of cows with the length of the grass supply** including inverted comparison of {-} values

Based on the interview transcripts, it is known that AF expressed statements that included comparisons of value, namely the number of salon workers with wages paid by the salon and the number of buyers with coffee provided at the coffee shop, while statements that included comparisons of inverse values, namely the speed of a car with travel time and the number of cows with long supply of grass. AF also revealed the reasons why the number of salon workers with paid wages issued by the salon and the number of buyers with coffee provided at the coffee shop is a comparison of value, the speed of a car with travel time and the number of cows with the duration of grass supply is a ratio of inverse value. So it can be concluded from the results of the answers to written assignments and interviews that subjects with moderate mathematical ability AF are able to classify comparisons of equivalent and reversed values. In accordance with the results of research conducted by (Yasma et al., 2022) subjects with moderate mathematical abilities are able to identify a concept correctly.

3.2.3 Give examples and non-examples of a concept

Research on AF subjects in providing examples and non-examples of value comparisons and comparisons of value returns was carried out by interviews. The following are the results of the researcher's interview with the AF subject in providing examples and non-examples of comparisons of value and return value.

AFM1 S1-037 S : {-} worth comparison example**amount of money to the number of items that can be purchased**

AFM1 S1-038 P : If not an example worth comparison?

AFM1 S1-039 S : **car speed with travel time**{-}

AFM1 S1-043 S : {-} example of reversed value comparison {-}**car speed with travel time.**

AFM1 S1-045 S : **A lot of money against the number of items that can be purchased** {-}

Based on the results of the AF interview, it was revealed that an example of a comparison of value is the amount of money to the amount of goods that can be purchased and not an example of a comparison of value, namely the speed of a car with travel time. AF also revealed an example of a comparison of inverse values, namely the speed of a car with travel time and not an example of a comparison of inverse values, namely the amount of money to the number of items that can be purchased. So it can be concluded that subjects with moderate math skills are able to give examples and not examples of comparisons of value and value. This is in line with the results of research from (Fajar et al., 2019) subjects with moderate math skills can provide examples and non-examples of a concept.

3.2.4 Using, Utylizing and Selecting Certain Procedures or Operations

Research on AF subjects in using, utilizing, and choosing the right procedures in solving the problem of comparison of values and comparisons of value returns was carried out by means of written assignments and interviews.

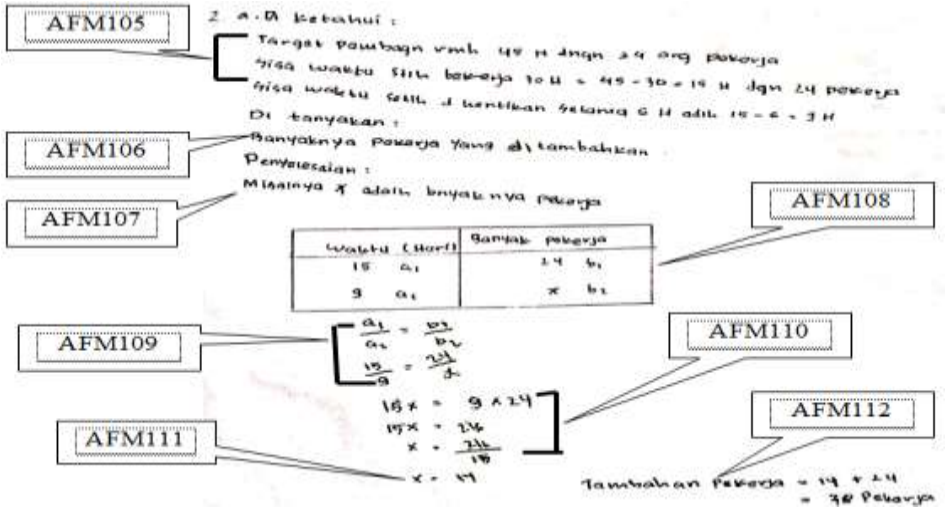

Figure 5 AF's answer uses, utilizes, and chooses the right procedure in solving the problem of comparing equal and inverse values of Problem Number 2 part a

The following are the results of the researcher's interview with the AF subject in question number 2 part a

AFM1 S2-069 S : {--} me**for example*x*** as the number of workers needed, then I**create table** this is ka (pointing to the table).

AFM1 S2-073 S : I am**enter** all values{-} a_1, a_2, b_1, and b_2{-} to the equation $\frac{a_1}{a_2} = \frac{b_1}{b_2}$, I get the equation $\frac{15}{9} = \frac{24}{x}$ from the table earlier, then I multiply {-} cross I get 15×x=24×9, then I multiply the result 15x=216. So to find the value of x {-} I divided 216 by 15 {-} so I got the result 14 {-} After that, to find the number of additional workers I added the initial number of workers with the number of workers obtained {-} (14+ 24). So the number of additional workers is 38 workers {-}

Next, an explanation of the results of the written assignment and the AF interview on question number 2 part b.

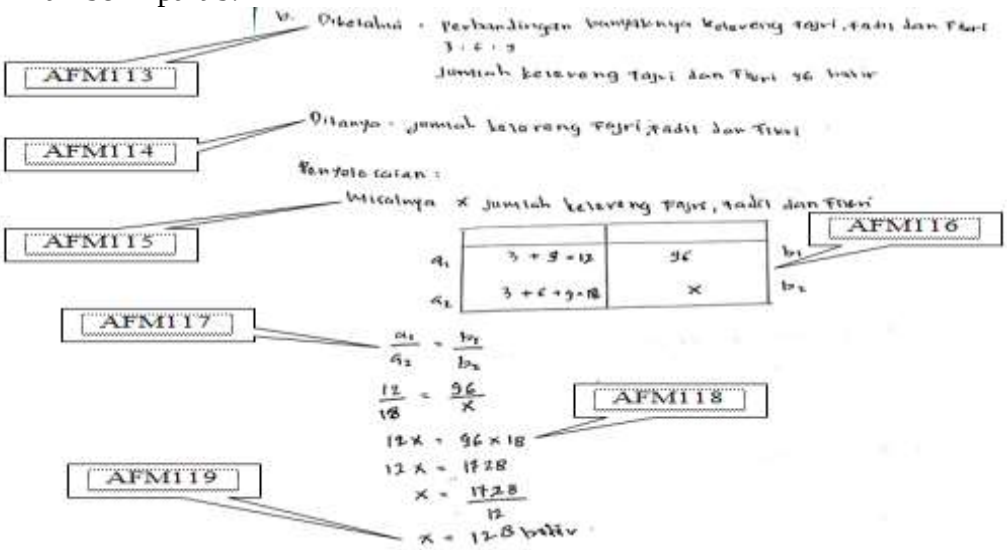

Figure 6 AF's answer uses, utilizes, and chooses the right procedure in solving the problem of comparing equal and inverse values of Problem Number 2 part b

The following are the results of the researcher's interview with the AF subject in question number 2 part b

AFM1 S2-079 S : Because the question{-} includes a comparison worth {-}

AFM1 S2-081 S : {-} the first one**is known** {-} the ratio of the number of marbles of Fajri, Fadil and Fikri is 3:6:9, meaning that there are 3 marbles owned by Fajri, 6 marbles owned by Fadil and 9 marbles owned by Fikri and the total marbles of Fajri and Fikri are 96 marbles. Then they asked about the number of marbles Fajri, Fadil and Fikri.

AFM1 S2-083 S : I **let x be the number of marbles for Fajri, Fadil and Fikri** {-} then **I made a table**. For the value of a_1, I get 12, a_2 is 18, then for b_1 it is 96 and b_2 is x {-}

AFM1 S2-087 S : Next, sis, I entered the {-} values into the equation $\frac{a_1}{a_2} = \frac{b_1}{b_2}$, to find the value of x and I got that $\frac{12}{18} = \frac{96}{x}$, after that I crossed it {-} I got 12x=96×18 and the result was 12x=1728. Then to get the x value I divided 1728 by 12, I got the result 128.

In accordance with the data from the results of written assignments and the results of interviews with subjects with moderate AF skills in using, utilizing, and choosing the right procedures to solve the problem of comparison of values and reverse values, namely writing down what is known and asking questions, then making a mathematical model and making tables. However, AF erroneously used the procedure to solve part (a) questions, namely AF used equivalent comparisons in reverse value comparison questions so that the final results obtained were not quite right. Furthermore, AF used the correct procedure to solve part (b) of the problem, namely using a comparison equation equivalent $\frac{a_1}{a_2} = \frac{b_1}{b_2}$ to the correct steps, but AF was not careful in carrying out the calculations so that the final result obtained was not quite right. So it can be concluded that subjects with moderate

mathematical abilities AF are able to use, utilize and choose the right procedure to solve value comparison problems but AF is less able to use, utilize and choose the right procedure to solve value comparison problems. This is in line with the results of research conducted by (Nurwana, 2019) subjects with moderate mathematical ability are able to identify what is known and asked about questions well, but are poorly understood, causing errors in selecting and using methods to complete answers.

3.3 Subjects With Low Mathematics Ability R

3.3.1 Restating a Concept

Research on subject R in expressing a concept was carried out by interview. The following is the result of the interview is the result of the R interview in stating a concept.

RM1 S1-006 S : **Comparison of equivalent value of one quantity increases, so the value of the other quantity also increases** and if**In reverse comparison the value of one quantity increases then the other quantity decreases** {-}

Based on the results of R's interview on M1 in restating the concept of equivalent and reversed value comparisons, by providing an explanation that a comparison of equivalents is a comparison of two quantities, if one of the magnitudes increases, the value of the other quantity also increases, and a comparison of equivalents is a comparison of two quantities, if one quantity increases, the other quantity decreases. From the results of the interviews, information was also obtained that R was unable to restate the comparative equations of equivalent and reversed values. So it can be concluded that subjects with low mathematical ability R are able to restate the concept of comparison of value and value in their own words but are unable to state the equation of comparison of value and value.

3.3.2 Identufying the Objects of a Concept

Research on subject R in identifying comparison objects of value and return value contained in question number 1 was carried out by means of written assignments and interviews.

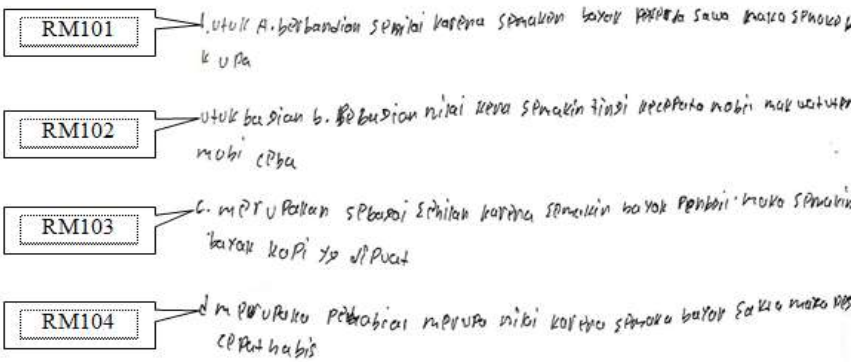

Figure 7 R's answer in identifying a comparison of worth and turn around value

The following is the result of the researcher's interview with subject R in identifying comparisons of value and return value.

RM1 S1-022 S : **The number of salon workers with paid wages issued by the salon and the number of buyers with coffee provided at the coffee shop** entered comparison worth while**the speed of a car with the travel time and the number of cows with the length of the grass supply**enter inverse comparison{-}

Based on the interview transcript on M1, information was obtained, R revealed that the statement included a comparison of value, namely the number of salon workers with paid wages issued and the number of copies made by the number of buyers in the coffee shop, while the statement included a comparison of inverse values, namely the speed of a car with time mileage and the number of cows with long grass supply. R also explained the reasons why the number of salon workers with paid wages issued by the salon and the number of buyers with coffee provided at the coffee shop is a comparison of value, the speed of a car with travel time and the number of cows with the duration of grass supply is a ratio of inverse values. So it can be concluded from the results of written assignment answers and interviews that subjects with low mathematical ability R are able to correctly identify equivalent and reversed value comparisons.

3.3.3 Give examples and non- examples

Research on subject R in providing examples and non-examples of value comparisons and comparisons of value returns was carried out by interviews.

RM1 S1-036 S : {-} which comparison is worth,**the amount of coffee made and the number of customers in the coffee shop** and not that example**the number of cows with a long supply of grass**.

RM1 S1-040 S : Examples of inverted comparisons bro,**the speed of a car with the time traveled** and not the example**the amount of coffee made by the number of buyers in the coffee shop**

Based on the interview transcript R revealed that examples of value comparisons were the number of coffees made and the number of customers at the coffee shop and not examples of value comparisons, namely the number of cows and the duration of grass supply. R also revealed an example of a comparison of inverse values, namely the speed of a car with travel time and not an example of a comparison of inverse values, namely the number of coffees made to the number of buyers in a coffee shop and not an example of a comparison of inverse values, namely the number of coffees made to the number of buyers in a coffee shop. So it can be concluded that subjects with low math ability R are able to provide examples and not examples of comparisons of value and reverse value but are still based on the questions given.

3.3.4 Using, Utilizing and Selecting Certain Procedures or Operations

Research on subjects with low mathematical ability R in using, utilizing and choosing the right procedures in solving problems of comparison of values and returns of value was carried out by means of written assignments and interviews.

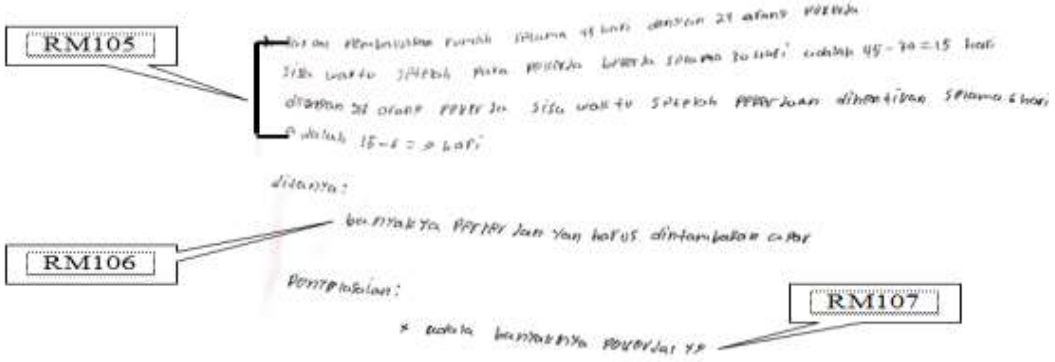

Figure 8 Answer R uses, utilizes, and chooses the right procedure in solving the problem of comparison of equal and reverse values of Problem Number 2 Part a

Following are the results of the researcher's interview with subject R

RM1 S2-058 S	:	Which**is known** from the problem, the work target is 45 days with 24 workers. Then the remaining time after working for 30 days with 24 workers is 15. Because it was stopped for 6 days, there are only 9 days remaining, sis.
RM1 S2-066 P	:	Then according to my sister, this question is a comparison of value or reverse value?
RM1 S2-067 S	:	Shut up. (while shaking head). I don't know sis.
RM1 S2-068 P	:	Now, look at the problem, what is known from part b?
RM1 S2-069 S	:	Shut up (while reading the question). I don't know bro.

Based on the results of the interviews, information was obtained that R used, utilized, and chose the right procedure in solving the problem of comparison of values and reverse values, namely writing down what was known from the problem, writing down what was asked from the problem. From the interview results also obtained information that R could not complete the answer to determine the valuex, R is only able to make a mathematical model of the problem, R does not know what method to use for the next step. In line with the opinion of (Toha et al., 2018) subjects with low ability are able to find known information and be asked questions, but are confused about what method to use to solve the problem. Subject R was also unable to answer part b questions because he did not understand the meaning of the questions. So it can be concluded that subjects with low mathematical abilities are unable to use, utilize and choose the right procedure to solve the problem of comparison of value and return value.

4. CONCLUSION

Based on the data analysis and discussion, it is concluded that the profile of students' understanding of the concept on material comparisons of value and return value in class VII A of SMP Negeri 1 Ampibabo. Subjects with high mathematical ability (SS) are able to restate the concept of comparison of value and return of value, identify, give examples and non-examples of comparisons of value and return of value and are able to use, utilize and choose the right procedure in solving problems of comparison of value and return of value.

Subjects with moderate mathematical ability (AF) are able to restate the concept of comparison of value and return, identify and provide examples and non-examples of comparisons of value and return, but are less able to use, utilize and choose the right procedure in solving the problem of comparison of value and return value, i.e. still confused about determining the problem which is a comparison of value or turning value.

Subjects with low mathematical ability (R) were able to restate the concept of comparison of value and value, were able to identify and give examples and non-examples of comparison of value and value, but were unable to solve comparison questions of value and value. Subject R did not understand the problem, did not know what method to use to solve the problem. R was only able to write down what was known and asked from the questions and was able to make a mathematical model of the value-reverse comparison questions.

In this study, researchers provide suggestions to be expected to be able to consider the results of this research and make it a reference in applying learning models to develop and hone students' conceptual understanding skills both orally and in writing.

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ANALYSIS OF THE NEEDS FOR DEVELOPING E-MODULES WITH FLIPPING BOOKS AS ETHNOMATHEMATICS-BASED TEACHING MATERIALS

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ABSTRACT

This research is research on the development of teaching materials in the form of e-modules based on ethnomathematics. This type is a qualitative descriptive research. The research data collection instruments were form of teacher needs analysis interview sheets, and student needs analysis questionnaires. The teaching material developed is the form of an e-module using a Flipping book. The research subjects consisted of a teacher and 28 grade VIII junior high school students. The results of the needs analysis obtained that 78.6% of students answered that they had textbooks or other guidelines but 61% of students answered that they did not look for learning materials anymore only from school books, as many as 75% of students wanted to learn using teaching materials other than textbooks or worksheets, then as much as 82% answered that the learning media used by teachers didn't contain culture in mathematical concepts, and 71% of students thought that it was necessary to use media e-modules based on ethnomathematics to learn mathematical concepts in culture. These results indicate that it needed to develop teaching materials e-modules based on ethnomathematics.

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1. INTRODUCTION

Mathematics is one of the fields of science that has an important role in education. The importance of mathematics can be seen from mathematics learning which is one of the compulsory subjects at every level of education in Indonesia as stated in the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System article 37 explicitly emphasizes that mathematics learning is one of the compulsory subjects for

students starting from elementary school to high school. This is because learning mathematics is needed in everyday life. Mathematics develops calculating, measuring, and problem-solving skills. All of these abilities aim to enable students to play an active role, in learning mathematics and in everyday life (Rizal et al., 2021). The importance of learning mathematics results in the need for effective and fun learning activities so that the expected learning objectives can be achieved. Efforts to achieve these learning objectives are to create fun learning and in accordance with the learning needs of students, one of which is the use of media. The media used in learning are usually textbooks or teaching materials. Many teaching materials are made not based on student characteristics that contain only a few concepts conveyed in them. Conventional and monotonous mathematics learning often causes students to become bored and uninterested so that innovation is needed in the learning process.

Choosing the form of teaching materials used by students can be seen from the learning conditions of students to be achieved and the disadvantages and advantages of the media to be used. A module is a form of teaching material that is commonly used by students. Currently the module form no longer has to be printed. Electronic module, which means digital or electronic form, is one of the most sought-after alternative forms of books because of several advantages that can cover the shortcomings of the print module, including: namely: 1) Can display the material more attractively. 2) Have interactive features with users, so that users can engage in media. This can reduce the saturation of users. 3) Can be carried anywhere without requiring large space. Because the modules developed can be operated on laptops, PCs, and smartphones. The format of internative electronic modules is now diverse, such as .exe, .epub or swf which has long been known to the public. This flipping book-based interactive electronic module is designed to support classroom learning, namely in mathematics subjects (Aulia et al., 2016). Electronic modules are teaching materials in the form of modules in electronic form that aim to increase student motivation and interest, e-modules that contain the display of images, videos, audio and animation so that they can be used by students independently at home or school.

Flipping book means a book or module that has a flip effect (rotating or flipping), causing animation as if turning the actual book sheet. Using flipping books is very easy, as well as reading other digital books that have been widely used such as digital books in pdf format. The only difference is how to read which can be done by flipping every corner of the sheet before and after with the help of a mouse or certain buttons. The flipping book to be designed uses Flip PDF Professional software.

Flip PDF professional is an interactive media that can easily add various types of aninative media to the flipbook. With just drag, drop or click, we can insert youtube videos, hyperlinks, animatic text, images, audio and flash into the flipbook. The features provided are very diverse, so that during development, the content of flipping books can be adjusted. The combination of text, images, audio, video makes making interactive digital books easier and provides interesting results (Aulia et al., 2016).

Technological advances make students vulnerable to forgetting the culture in Indonesia. Students tend to prefer learning through electronic media such as the internet and gadgets that mostly access foreign cultures. Education and culture according to (Yulia & Muchlian, 2019) are things that cannot be separated in everyday life. In Indonesia, the curriculum is adapted to contexts such as culture and life. The need for an attitude of respecting and combining cultural knowledge with life practices, so that people are inseparable from the original culture of Indonesia which is full of noble values. One way to teach culture to students is through mathematics learning (Purwoko et al., 2020).

Ethnomathematics is a form of learning approach that links local culture in mathematics learning. Ethnomathematics in this study focuses on the Lampung Traditional House and also traditional Lampung cakes. Lampung Traditional House and Lampung traditional cake can be connected in mathematics material build flat side room. So it is expected that students can learn mathematical concepts and cultural values that can name good character in students.

Research related to the development of ethnomathematics-based teaching materials has been carried out by many previous researchers. His research (Rudyanto et al., 2019) shows that the development of ethnomathematics-based learning tools can provide solutions for mathematics teachers to innovate mathematics learning. Similarly (Purwoko et al., 2020) shows that teaching materials such as electronic-based modules need to be developed because students do not always learn to use teaching materials in general, it is hoped that by using fun teaching materials such as electronic modules, students are able to change their opinions and views that mathematics is a difficult but fun subject. Meanwhile, the quadrilateral material can be arranged by applying ethnomathematics to it, namely the cultural products of Central Java.

Based on the above problems, a new breakthrough is needed to make it easier for students to understand mathematical material by linking the material learned at school and ethnomathematics and utilizing technology in the learning process. Therefore, researchers conducted a research analysis of the needs of developing ethnomathematics-based mathematics e-modules with FlippingBook.

2. METHOD

This study uses qualitative descriptive method which aims to analyze the need for ethnomathematics-based e-modules. Qualitative descriptive research describes, describes, explains, explains, and answers in more detail the problem to be studied by studying an individual, an individual, or an event. The descriptive approach is used based on the consideration that the problems to be studied are ongoing now which aims to analyze the phenomena that occur in the field (Afriliziana et al., 2021).

This research was conducted at SMPN 3 Tulang Bawang Barat with the subjects in this study being grade VIII students as many as 28 students. Data collection techniques in this study used questionnaires and interviews. Data analysis using Analysis Interactive from Miles & Huberman (Emzir, 2014), analysis consists of three lines of activities that occur simultaneously, namely: data reduction, data presentation, conclusion drawing / verification. The stages of data analysis in this study are

as follows; (1) record all findings of the phenomenon through an interview with a grade VIII mathematics teacher of SMPN 3 Tulang Bawang Barat. This is done to determine the analysis of teaching material needs to be developed in the form of e-modules based on Lampung cultural ethnomathematics, (2) after collecting data, then the data is reduced by analysis that sharpens, classifies, directs, discards unnecessary, and organizes data in such a way that final conclusions can be drawn and verified, (3) describe data that has been classified with attention to focus and purpose research, (4) make a final analysis in the form of a research report.

3. RESULTS AND DISCUSSION

The needs analysis refers to the conditions that exist in the school, namely at SMPN 3 Tulang Bawang Barat. This analysis is needed to find out whether the media really needs to be developed or not. Needs analysis is carried out in two stages, namely the distribution of

questionnaires to students to find out whether students want to learn using electronic module teaching materials or not and an interview with a mathematics teacher. From the distribution of questionnaires to 28 respondents, data on the results of student response questionnaires were obtained which are described below:

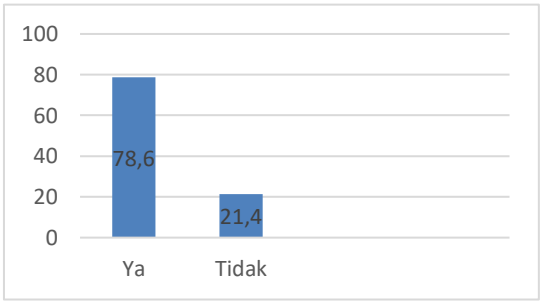

Figure 1. Student Response to Question 1

Based on figure 1. The results of the questionnaire that has been given to grade VIII students to the first question is "Do you have textbooks or other handbooks to study at school?". Figure 1 shows that 78.6% of students answered that they had textbooks or other manuals such as printed books and students answered that they did not have manuals or other manuals for learning as many as 21.4%.

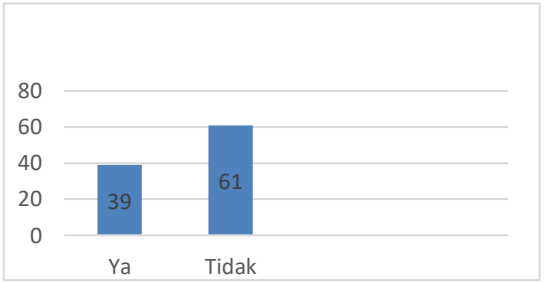

Figure 2. Student Response to Question 2

Based on diagram 2 which illustrates the results of the questionnaire that has been given to grade VIII students on the second question, namely "Are you looking for learning materials other than books from school to study?", as many as 39% of students answered that they were looking for learning materials again other than books provided by the school and 61% of students answered that they were not looking for learning materials anymore only from school books to study.

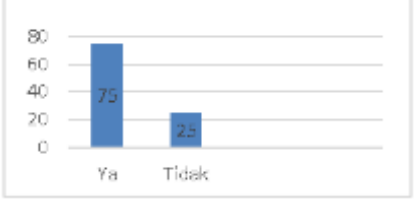

Figure 3. Student Response to Question 3

In figure 3. describing students' responses to the question "Do you want to learn using teaching materials other than textbooks or LKS?", as many as 75% of students want to learn using teaching materials other than textbooks or LKS and as many as 25% of students do

not want to learn using teaching materials other than textbooks or LKS. This shows that students want other teaching materials besides textbooks or LKS so that they are able to understand learning materials both individually and in groups.

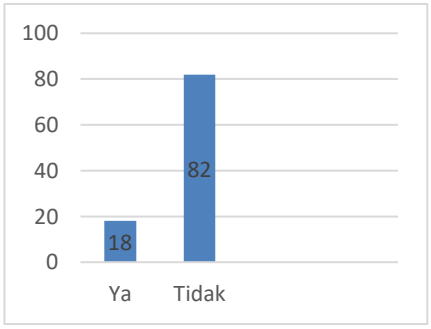

Figure 4. Student Response to Question 4

Based on figure 4. The results of the questionnaire on the fourth question were "Does the learning media used by teachers already contain culture in their mathematical concepts?", in the opinion of grade VIII students as many as 18% of students said the learning media used by teachers already contained culture in their mathematical concepts and 82% answered that the learning media used by teachers did not contain culture in mathematical concepts.

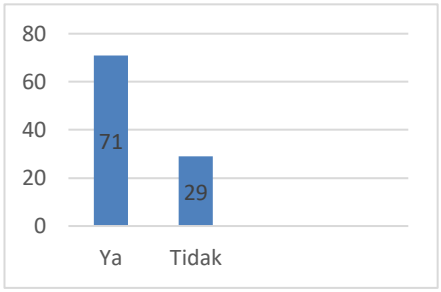

Figure 5. Student Response to Question 3

Based on figure 5. Regarding students' responses to the question "Do you think it is necessary to use learning media in the form of e-modules to learn mathematical concepts in culture?", as many as 71% of students thought that the use of learning media in the form of ethnomathematics-based electronic modules was needed to learn mathematical concepts in culture and as many as 29% answered unnecessary.

The results of observations and interviews with teachers stated that the curriculum used was the 2013 curriculum, the teaching materials used were government package books and LKS. The package book is a compulsory book that must be used in schools in Indonesia. The existence of the 2013 curriculum-based government package book in schools is very helpful for teachers in the learning process. All the material contained in it is so complete and contains a lot of problem solving which really helps students to improve problem solving skills. However, the 2013 curriculum turned out to be able to cause problems, namely the unpreparedness of students for teaching materials or package books based on the 2013 curriculum. Students still find it difficult with abstract problems in the textbook that must be solved by students and the level is too high for students to make it difficult to understand. The learning process at school is adjusted to the level of student development. Because learning activities that are not in accordance with the level of student development make learning activities ineffective. In practice, teachers often use only one textbook. Meanwhile,

it is known that textbooks do not discuss widely and deeply, so they cannot help develop students' ideas and concepts fully.

Based on interviews, information was also obtained that the use of mathematics learning media is still lacking and there is no application of electronic-based teaching materials as learning media. Teachers only provide assignments and materials or just convey learning through printed books. This shows that there has been no innovation in electronic teaching materials developed such as e-modules. Because there is no teaching media innovation other than printed books, this has an impact on low student motivation in learning activities. Students feel bored due to monotonous learning. This can be seen from the decline in students' daily test results. The use of ICT in learning aims to improve their desired teaching methods and approaches to achieve effective learning activities as well as to meet the challenges of 21st century teaching skills (Ghavifekr & Rosdy, 2015). Teaching materials such as electronic modules need to be developed because students do not always learn to use teaching materials in general, it is hoped that by using fun teaching materials such as electronic modules, students are able to change their opinions and views that mathematics is a difficult but fun subject. It is hoped that mathematics teaching materials in the form of electronic modules can make students happy and enthusiastic to learn mathematics, and are also expected to increase their insight into the culture around them. Not only that, the learning method used is the question and answer method and discussion. The use of methods in mathematics learning must be adjusted to the material to be delivered in learning, the time needed, and the teacher's ability to master the method. Good mathematics learning requires the use of varied learning media.

Material analysis is carried out by examining the subject matter to be taught. The material analysis was also based on the results of an interview with a mathematics teacher of SMPN 3 Tulang Bawang Barat who supervised class VIII by selecting the appropriate material and systematically rearranging it. The material used is adjusted to the Syllabus, Learning Implementation Plan (RPP), and mathematics books written by the Indonesian Ministry of Education and Culture so that learning objectives are achieved. The results of the material analysis stated that the material to be taught for the even semester of class VIII is to build a flat side room. The material of building a flat side space can be arranged by applying ethnomathematics to it.

In the process of distributing the questionnaire, another fact was obtained that at first glance was not seen directly, namely the fact that students were still lacking in elements of manners and cultural elements, this could be seen from how they talked to their teachers, talked to people older than them. Learning models with ethnomathematics-based approaches have not been used in learning. D'Ambrosio illustrates that mathematics is very broad when connected in life that can be practiced among identifiable cultural groups, such as ethnic groups, working groups, children of a certain age and professional classes. Ethnomathematics is a field that studies the ways in which humans from different cultures understand, pronounce and use concepts from their cultures related to mathematics. So that in ethnomathematics it can be studied how people understand, express and use cultural concepts that are described mathematically (Hariastuti, 2017). Sirate explained that learning that is associated with culture and tradition will motivate students to obtain meaningful learning. Ethnomathematics is learning by integrating mathematical concepts and practices with cultural elements and traditions that can increase students' understanding. This is as according to (Himmatul & Rahayu, 2017) that students will more easily understand mathematical concepts through culture-based learning. Through the application of ethnomathematics in education, especially mathematics education, it is hoped that later

students can master targeted mathematical abilities without leaving their cultural values. Applying ethnomathematics as a learning model will greatly allow the material learned to be well understood.

Based on the above explanation and the field conditions, it is necessary to design an ethnomathematics-based mathematics E-Module teaching material to facilitate students during the mathematics learning process.

4. CONCLUSION

Based on the results of research and discussion, it can be concluded that the development of ethnomathematics-based e-modules is important to be carried out according to the needs of teachers and students of SMPN 3 Tulang Bawang Barat. Based on the results of a questionnaire conducted on 28 respondents or students of SMPN 3 Tulang Bawang Barat, 78.6% of students answered that they had textbooks or other handbooks such as printed books, but 61% of students answered that they did not look for learning materials anymore only from school books to study, as many as 75% of students wanted to learn using teaching materials other than textbooks or LKS, Then as many as 82% answered that the learning media used by teachers did not contain culture in mathematical concepts, and as many as 71% of students thought that the use of learning media in the form of ethnomathematics-based electronic modules was needed to learn mathematical concepts in culture.

Based on the results of an interview conducted with one of the educators at SMPN 3 Tulang Bawang Barat and the discussion above, it was concluded that the availability of package books in schools still poses problems for students. Students find it difficult with abstract problems in the textbook that must be solved by students and the level is too high for students to make it difficult to understand. So that teachers and students need teaching materials in the form of modules to support books at school. The conclusions obtained are: Students need a learning resource to be able to strengthen understanding Students are exposed to mathematics subjects and need learning resources that can be understood independently. So that what is suitable for use is ethnomathematics-based e-module teaching materials that can contain text, images, and videos.

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ANALYSIS OF STUDENT ERRORS IN SOLVING MATRIX PROBLEMS IN CLASS XI OF SMK MUHAMMADIYAH DELANGGU

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ABSTRACT

This study sought to describe mistakes made by SMK Muhammadiyah Delanggu's grade XI students with high, medium, and low abilities when solving matrix problems. It also sought to describe mistakes made by SMK Muhammadiyah Delanggu's grade XI students with concepts, principles, and procedures. This exploration is an engaging subjective examination. The instrument utilized a composed test that included two things, four framework material test questions and meetings were utilized as extra instruments. 14 XI students who had studied matrix material served as the study's subjects. By gathering information from giving composed test questions, understudy mistakes can be distinguished. According to the findings of this study, students of high ability understood the concepts and principles, but performed mathematical operations incorrectly; students of medium ability made procedural errors due to a lack of accuracy in matrix multiplication calculations; and students of low ability made numerous concept, principle, and procedure errors.

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1. INTRODUCTION

Mathematics is a basic science that helps to know other sciences (Yantoro et al., 2021). One of the important concepts in mathematics is the matrix, which has wide applications in various fields such as computer science, engineering, economics, and natural sciences (Howard, A., 2013). Even though the matrix is a basic concept, students often have difficulty understanding and solving problems related to the matrix. Therefore, error analysis

in solving matrix problems is important to help educators and students understand which parts they need to improve understanding.

Through a good educational process will produce quality seeds and increase students' understanding. students can expand their knowledge, abilities, and creativity towards the progress of science and technology through formal education. Learning mathematics is one of the things that is done to increase ability and creativity. Learning mathematics is done to become better at solving problems. The following explains why it is so important to acquire mathematical skills so that you can use them to solve problems in everyday life. The term "able" comes from the concept of power, capacity, and ability (Poerwadarminta, 2005). (Uno, 2008) notes that "a person's ability to work refers to his effectiveness at work, which is reflected in his thoughts, attitudes and behavior." But on the other hand, mathematics compared to other subjects is considered a challenging and even frightening science for students.

According to Newman (Fausan, Sagita, G., 2019), student errors in mathematics usually belong to five groups: understanding errors, awareness errors, change errors, and ability errors, notation errors are listed in that order. According to (Wulandari & Resta, 2018), there are four types of errors students might make when completing numerical statements: theoretical errors, guideline errors, functional errors, and sloppy errors. Students' lack of conceptual understanding of the material they have learned, their inability to understand the language of mathematics, the application of incorrect mathematical formulas, and their thoroughness are the main reasons for errors (Badaruddin, Kadir, & Anggo, 2016).

According to (Ardiawan, 2018), errors are systematic deviations from the correct answer. Error analysis is an attempt to identify, find, and categorize errors according to established principles. Argues that it is necessary to examine student errors in order to identify the various mistakes students make. The type and location of the error can be identified through this analysis, so that the teacher can provide the appropriate answer to ensure that the error can be overcome and does not occur again (Yuni Astuty & Wijayanti, 2013). Information about mistakes made when answering math problems can also be used to help learn math. One of the mistakes that students often make is that it is still difficult to understand the meaning of the questions, especially in matrix material.

The matrix is a sub-material in mathematics. The field of matrix theory covers a wide range of topics, including terms used in matrices, matrix shapes, matrix transposition, matrix similarity, and operations on matrices such as addition, subtraction, multiplication, and inverse operations as well as solving systems of linear equations and matrix equations with matrices and determinants. It is known that certain students perform poorly on the matrix material based on the results of daily tests from the previous year. This is because there are still many students who make mistakes when solving problems involving matrix material, especially when calculating matrix operations, applying matrix concepts, matrix determinants, and matrix equations.

The researcher focused on analyzing the descriptions of students' errors in solving matrix problems with variations in students' mathematical abilities, especially the ability of individual students as measured by the mathematical ability test scores, because the researcher wanted to describe how the description of the errors of students with high, medium, and low mathematical abilities in completing a problems related to matrix.

2. METHOD

This research is included in the descriptive qualitative research which aims to describe students' mistakes in solving matrix material questions. This study focused on 14 class XI students of Muhammadiyah Delanggu Vocational School who had received matrix

material. Classes are taken from the suggestions of subject teachers at school. The instruments given were a two-question ability test and a four-question math test. The instrument was examined by two supervisors and it was stated that the test instrument was valid. The test given to all students in one of class XI at the Delanggu Muhammadiyah Vocational School aims to trace errors in concepts, principles, and procedures that students carry out. While interviews were conducted with selected respondents with different levels of ability with the aim of exploring and clarifying student answers in depth.

3. RESULTS AND DISCUSSION

3.1. Results

According to the results of the four description questions, the students tried to answer correctly even though there were some mistakes. In general, the results of student work when answering the questions presented showed that some students still remembered and understood the matrix material, while other students did not remember how to do the matrix questions. The results of the mathematics ability test which were taken by students of class XI at SMK Muhammadiyah Delanggu were shown for Table 1.

Table 1. Class XI Students' Mathematical Ability Test Results

No.	Name Initials	Mathematical Ability Test Results		
		High	**Medium**	**Low**
1	ASA	100		
2	SDAA			45
3	MAPW	80		
4	NNH		75	
5	MRD		60	
6	ASDR			40
7	SKB		70	
8	SY			50
9	AYR	100		
10	YDTE			45
11	NLM			45
12	MNF			40
13	IL		75	
14	PAN			40

The researcher divided the students into several categories based on the test results above and their math ability scores. Three categories including high, medium, and low abilities are used to categorize students. After that, as stated in **Table 2** following are the students who were selected as research subjects.

Table 2. Research subject

Students' Mathematical Ability	Student Initials	Average
High	MAPW	93
Medium	SKB	70
Low	SY	43

Each research subject was given a math test which contained four questions about matrix material according to the categorized table results. The test distributed has met the validity requirements of the expert. Concept, principle, and procedure errors are several types of errors found in the test results given to each group of students. **Table 3** below shows a recapitulation of the different types of errors.

Table 3. Types of High Ability Student Errors

Student	Problem 1			Problem 2			Problem 3			Problem 4		
	Co	Pr	Pr	Co	Pr	Pr	Co	Pr	Pr	Co	Pr	Pr
	√	√	-	√	√	√	√	√	√	√	√	√
MAPW												

Problem number 1 discusses matrix transpose, matrix operations, and multiplication of two matrices. Table of Error Test Results as shown by the student above, the subject had no difficulty in solving the problem about transpose matrix in problem 1. However, the student made a mistake in calculating the matrix operation. The results of student work show that students are able to record answers based on concepts and principles, but are not careful in calculating mathematical operations. Figure 1 shows the results of student work.

Table 4. Types of Medium Ability Student Errors

Student	Problem 1			Problem 2			Problem 3			Problem 4		
	Con	Pri	Pro	Con	Pri	Pro	Con	Pri	Pro	Con	Pri	Pro
	√	√	-	√	-	-	√	√	√	√	√	√
SKB												

Problem number 2 discusses the multiplication of two matrices and matrix operations. From the Table of Student Error Test Results above, it is clear that students do not understand how to answer questions involving matrix operations in question 2. Students find it difficult to work on questions regarding principles and procedures.

Table 5. Types of Low Ability Student Errors

Student	Problem 1			Problem 2			Problem 3			Problem 4		
	Con	Pr	Pr	Con	Pr	Pr	Con	Pr	Pr	Con	Pr	Pr
	√	√	-	√	√	-	-	-	-	√	-	-
SY												

Questions 3 and 4 discuss the operation of multiplying two matrices, matrix determinants, and matrix inverses of the order 2x2 and 3x3. The table of Student Error Test Results shows that the individual experienced difficulties when solving matrix problems. Students have difficulty when trying to solve questions that require an understanding of concepts, principles and procedures in questions 3 and 4.

The following is an excerpt from the conversation between the researcher and students with high intelligence about problem number 1.

Researcher : Do you understand after reading the question?
MAPW : yes I understand ma'am
Researcher : try to explain the meaning of transpose matrix

MAPW : transpose matrix is the exchange of positions in a part of the matrix by rows into columns.

Researcher : but in the search for the value of c you are wrong in the mathematical operation

MAPW : yes ma'am I was not careful when calculating it

According to the results of interviews between researchers and high-skilled students, it was found that the subject could explain what the transpose matrix means through simple language, but was not careful when doing mathematical calculations. **Figure 1** displays the results of student work.

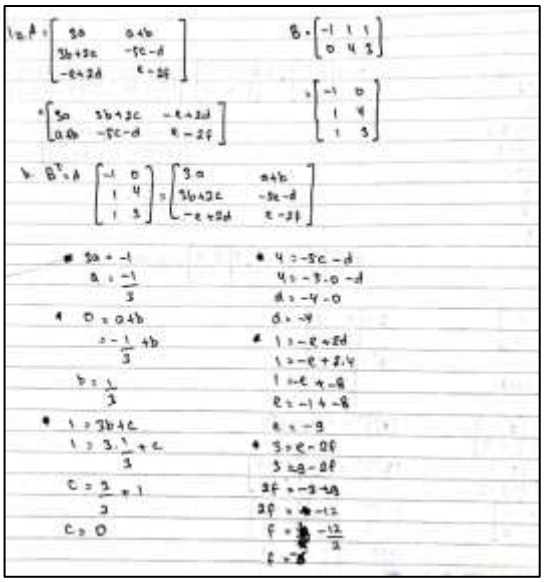

Figure 1. Results of High Ability Students on question number 1

Students prepare assignments using existing principles and concepts, as shown in the image above. But in the search for the value of c, it is wrong to calculate the mathematical operation.

In contrast to high-quality students, students with moderate skills work with a different strategy for question number 2. The results of the answers of moderate-skilled students, for example, are presented Figure 2.

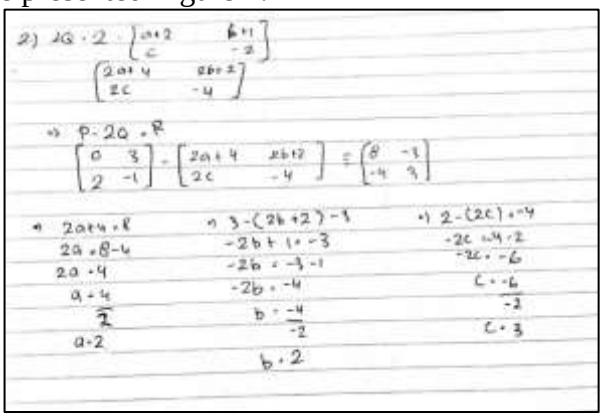

Figure 2. Results of Medium Ability Students for question number 2

The following figure explains if students are not careful in doing multiplication of switches with matrices. The following is an excerpt from the conversation between the researcher and the medium skilled students about question number 2.

Researcher : Are you sure from preparing question number 2 that you have the correct answer?
SKB : Not sure ma'am
Researcher : which part are you not sure?
SKB : In the multiplication of numbers and matrices, I'm still confused, ma'am
Researcher : do you know the switch multiplication with the matrix?
SKB : I don't understand if the sign is different (-) x (+)
Researcher : OK, I'll study it again, OK, the multiplication of switches and matrices, and be more thorough in doing it
SKB : Okay ma'am

Low quality student outcomes when tackling matrix problems are explained for Figure 3.

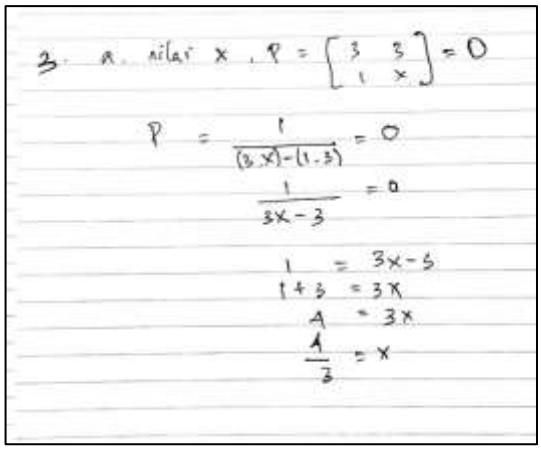

Figure 3. Results of Low Ability Students on question number 3

The picture above shows the work of low-ability students who do not understand multiplication formulas and operations in matrix problems. The student does not understand the concepts, principles and procedures in question number 3.

The following is an excerpt from the conversation between the researcher and low-ability students about question number 3.

Researcher : Do you not understand the meaning of question number 3?
SY : Yes ma'am I do not really understand
Researcher : in your opinion, where is the difficulty?
SY : in the working formula section ma'am and not careful when calculating

Researcher : here it is true that you are wrong in using the formula and the results are all wrong, please understand the meaning of the problem again and don't be careless anymore when calculating the operation.
SY : okay ma'am

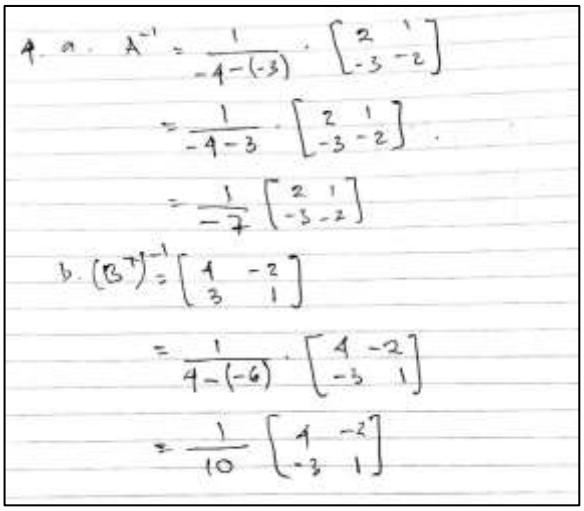

Figure 4. Results of students with low expertise on question number 4

The picture above shows the results of students with low skills on question number 4. The student was not careful when calculating the addition and subtraction operations.

The following includes excerpts from conversations between researchers and low-skilled students about problem number 4.

Researcher : do you know what is matrix inverse?
SY : I do not know ma'am, but the formula knows
Researcher : ok, here you are right when you enter into the formula but are not careful when calculating the addition and subtraction operations
SY : yes ma'am, I know there is a miscalculation
Researcher : Tomorrow I will be more careful when calculating the addition and subtraction operations
SY : okay ma'am

3.2.Discussion

Based on the written answers of students who have high intelligence for question number one, the following errors were found: This is in accordance with the theory (Wiyartimi, 2010) that there are various types of errors made by students, one of which includes operational errors, especially errors made students when using mathematical operations, this is supported by the persistence of students who are not easy when solving calculation problems. The student is using the concept correctly to determine how to transpose A and B, but is still having difficulty with the counting task. As a result, the student's answer becomes incorrect.

Students with moderate ability levels make mistakes when multiplying scalars by matrices. When multiplying a certain scalar value by each element of the matrix, the sign on the scalar value is not included. This error is caused because the student performs the wrong mathematical procedure. According to (Utami, 2012) arithmetic errors are mistakes made when performing mathematical operations including adding, subtracting, multiplying, and dividing. Students have not seen when answering questions so an error occurs.

According to the results of the answers given by students with low abilities on questions 3 and 4, it is generally assumed that these students made several mistakes, especially errors in understanding the concept of matrix equations and errors in determining the formula, which led to errors in determining the inverse of the transpose matrix B. This is in accordance with research (Wijayanti, 2010) by showing that many students have difficulty

understanding equations. Formulas must be learned and understood by students because just remembering them will not be enough.

4. CONCLUSION

According to the results and previous discussion, the following are conclusions that can be drawn by each group of students.

1. For students with high numerical abilities, it turns out that these subjects have not made mistakes in concepts and principles. It was explained if the students were able to prepare the questions correctly. But the math calculations are still wrong. From the results of the interviews it appears that the subject is able to provide additional explanations through language that is straightforward and easy to understand.
2. For students with medium numerical abilities, they can answer the questions given according to the concepts and principles correctly. However, students made procedural errors because they handled the problem of scalar multiplication with an incomplete matrix.
3. Students with low numerical skills often make mistakes for all three categories. The subject made a conceptual error in determining the formula. Likewise, the subject was not careful in calculating the subtraction operation so that procedural errors occurred.

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SPLDV QUESTION SOLUTION PROFILE OF MTs AL-KHAIRAT TOMINI STUDENTS BASED ON STUDENT LEARNING STYLE

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ABSTRACT

This research aims to obtain a description of the problem-solving profile of two-variable linear equation systems of MTs Al-Khairat Tomini students based on the student's learning styles. This type of research is qualitative. The subjects of this research were three students in class VIII B MTs Al-Khairat tomini, each consisting of one student with visual, auditory, and kinesthetic learning styles. Data on student problem-solving was obtained from written tests and interviews. This research shows that the subject (IN) carries out the problem-solving plan by the solution plan questions, and the subject did not recheck the problem-solving because he did not understand how to do it. The subject (MA) carries out the problem-solving plan by the problem-solving plan, and the subject can check and solve questions by checking the written answers again.

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1. INTRODUCTION

Mathematics is a branch of science that plays an important role in human life, both in knowledge and technological development. Therefore, mathematics is one of the subjects that must be taught at every level of education, from elementary school, middle school, high school to college. (Suningsih & Istiani, 2021)revealed that the skills resulting from studying

mathematics create skills for systematic logical thinking, innovation, creativity, etc. which are the basis for creating innovations in the development of science and technology.

One of the objectives of learning mathematics in the 2013 Curriculum as contained in the Attachment to Minister of National Education Regulation No. 58 of 2014 in the mathematics subject guidelines is to understand mathematical concepts, which is a competency in explaining the relationship between concepts and using concepts and algorithms in a flexible, accurate, efficient and precise manner in solving problem.

In line with the general learning objectives, the National Council of Teacher Mathematics or abbreviated as NCTM in(Ihsanudin & Rafianti, 2022)stated that there are 5 process standards in learning mathematics, in these five standards, namely mathematical connections, mathematical communication reasoning, mathematical proof, and problem solving. This statement makes it clear that someone who solves questions or problems is very necessary for a mathematics learning goal.

There are several experts who put forward problem solving steps, one of which, according to Krulik and Rudnick, is (1) reading; (2) explore; (3) choosing a strategy; (4) Completion; (5) review and discuss. Krulik and Rudnick are deep (Budiarti & Lestariningsih, 2018) stated that problem solving is a method that someone uses knowledge, skills and understanding to meet the demands of students who do not routinely. Indicators for solving mathematics problems according to Sumarmo (2003) are: (a) identifying the elements that are known, what is being asked and the adequacy of the elements required; (b) formulate mathematical solutions or construct mathematical models; (c) apply strategies to solve various problems (similar and new problems) within or outside mathematics; (d) explain or interpret the results of solutions using mathematics in a meaningful way.

Based on the results of research conducted by Andreas in(Budiarti & Lestariningsih, 2018),When students solved math problems, it was found that there were students who showed very good abilities in solving math problems, there were students who showed mediocre abilities and there were students who experienced difficulties, especially in the material on systems of linear equations in two variables.In the opinion of Andreas (2013), most students write down systematic steps to solve questions, namely starting by writing down what is known, asking questions and then solving the problem. Even though they show similarities in writing down the steps in solving systematic problems, they are seen in terms of identifying things that are known and asked about a problem which have implications for differences in solving problems.

Ruseffendi in(Budiarti & Lestariningsih, 2018) posing a question is a question for students who have the knowledge and ability to solve it. On another occasion Ruseffendi was in(Budiarti & Lestariningsih, 2018)also stated that a problem is a problem for students if first, the problem is unknown to them. Second, students must be able to solve it, both in mental readiness and knowledge, regardless of whether the student finally arrives at the answer or not. Third, something is a solution to the problem for him, if the student has the intention to solve it.

Based on the explanation above put forward by experts, it can be concluded that by looking at the problem solving, researchers can find out how students work on questions using the knowledge, skills and understanding possessed by students and by looking at problem solving, researchers do not only see the results obtained by students but also see the students' steps in answering the question.

Students as unique individuals certainly have their own characteristics. Because one another has differences in various aspects, especially in the learning process. One of them is the difference in ability to understand, absorb and process information. According to De Porter in(Zagoto, et al, 2019)A person's learning style is a combination of these abilities.

With so many student learning styles, it should be a reference for a teacher to develop students' thinking abilities so that the learning provided is appropriate to the students' conditions. As stated by Martinez-pons (2001: 7) in the psychology of teaching and learning, in a lesson the teacher must carry out the initial phase of learning, namely the stage where a teacher knows and understands the initial abilities possessed by his students. One of the initial abilities here is knowing the student's learning style so that the teacher can know the right learning strategy to overcome the mistakes made by students in solving problems on systems of linear equations in two variables in terms of their learning style.

Based on the results of information with one of the mathematics teachers at MTs Al-Khairat Tomini, it was revealed that students still experienced difficulties when deciphering the form of the problem so they had difficulty finding the solution. This makes student learning outcomes lower. With the various learning styles that students have and the varied ways of solving questions by students, a more detailed description of how to solve questions by students from various learning styles is needed.

2. METHOD

This research approach method is a qualitative descriptive approach. This research was carried out at MTs Al-Khairat Tomini, Tomini sub-district, Parigi Moutong district, Central Sulawesi province. This research was carried out in the even semester of the 2022/2023 academic year. The selection of subjects in this research was based on the results of the student learning style questionnaire given by the researcher. The questionnaire is given to find out what type of learning style the students have. In the learning style questionnaire there are 20 illustrations with three answer choices, where answer choice A shows the visual learning style type, answer choice B shows the auditory learning style type and answer choice C shows the kinesthetic learning style type.

Based on the results of the learning style questionnaire for class VIII B students at MTs Al-Khairat Tomini with a total of 22 students, it was found that there were 15 students with a visual learning style, 3 students with an auditory learning style and 4 students with a kinesthetic learning style. Next, the researcher took one subject from each student's learning style by asking for advice from the Mathematics teacher of the class to be studied.

Based on joint considerations with the mathematics teacher, 3 research subjects were obtained with each learning style presented in

Table 1. Research subject

Student Name Initials	Types of Learning Styles
IN	Visual
M.A	Auditory
MR	Kinesthetic

After determining the research subject, the researcher then carried out data collection. Data collection was carried out in the teacher's office where questions were given and completed, then continued with interviews. And test data credibility using time triangulation. Time triangulation was carried out by giving two tests, namely problem 1 and problem 2at different times to research subjects. To check the data, this was done by re-administering the problem-solving test with the same type of questions and using the same interview. Then the data for problem 1 and problem 2 were compared to see the subject's consistency in answering the questions that had been given.

3. RESULTS AND DISCUSSION

3.1. Results

Based on the description of the research results, the problem-solving profile of a system of linear equations in two variables of MTs Al-khairat Tomini students is discussed based onstudent learning styles. The questions used in this research are as follows:

1. Anisa bought notebooks and pencils, it is known that the price of 4 notebooks and 2 pencils was IDR 13,000.00, while the price of 3 notebooks and a pencil was IDR 9,000.00. What is the price if Anisa buys 5 notebooks and 2 pencils?
2. Alya bought an eraser and ruler, it is known that the price of 2 erasers and 3 rulers was Rp. 6,000.00, while the price of 4 erasers and 2 rulers was Rp. 8,000.00. What is the price if Alya buys 3 erasers and 2 rulers?

Figure 1. Student Work Result (IN)

Based on the presentation of answers and interview results at the stage of understanding the questions, a description was obtained that IN stated in writing the information known from the question (Figure 1), IN stated verbally the information understood from the question, IN explained the information that was known and was asked, IN stated the existing information enough to answer what is asked in the question.

Based on the presentation of IN's interview results at the planning stage for solving the problem, a description was obtained that IN made an example with the symbols x and y to show "price", IN made a mathematical model for the equation based on what was known from the problem, and IN wanted to solve the problem using a combined method (elimination and substitution)

Based on the presentation of IN's answers and interview results at the stage of implementing the problem solving plan, a description was obtained that IN implemented the problem solving plan in accordance with the planning stage for solving the questions. Namely making examples, creating mathematical models in the form of equations, eliminating and substituting.

Based on the presentation of IN's interview results at the stage of re-checking the problem solving, it was obtained that IN was sure of his answer, IN looked again at the answer that had been written, IN did not understand how to prove or double-check whether

his answer was correct, and IN concluded that the price of 5 notebooks and price for 2 pencils 15,500.

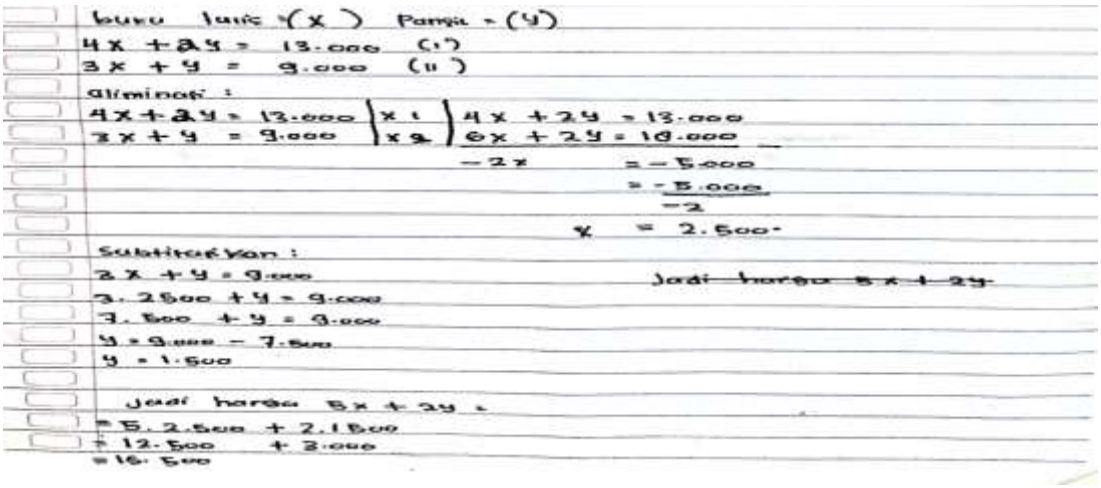

Figure 2. Student Work Result (MA)

Based on the presentation of the results of MA's interview at the stage of understanding the question, a description was obtained that MA stated verbally the information understood from the question, MA stated verbally the information asked about in the question, and MA stated that the information was sufficient to answer what was asked in the question.

Based on the presentation of the results of MA's interview at the planning stage for solving the problem, a description was obtained that MA wanted to make an example by using x and y to show "price", MA wanted to make a mathematical model in the form of an equation, and MA wanted to solve the problem using a combined method.

Based on the explanation of the answers and results of the MA interview at the stage of implementing the problem solving plan, a description was obtained that the MA was carrying out the problem solving plan in accordance with the planning stage for solving the questions. Namely making examples, creating mathematical models in the form of equations, eliminating and substituting.

Based on the presentation of the results of MA's interview at the stage of re-checking the problem solving, a description was obtained that MA was confident in his answer, MA knew how to prove or check whether his answer was correct, and MA concluded that the price of 5 notebooks and 2 pencils was 15,500.

Figure 3. Student Work Result (IN)

Based on the presentation of MR's interview results at the stage of understanding the questions, a description was obtained that MR stated verbally the information he understood from the questions, and MR stated that the information was sufficient to answer what was asked in the questions.

Based on the presentation of MR's interview results at the planning stage for solving the problem, a description was obtained that MR wanted to make an example using x and y symbols, MR wanted to make a mathematical model in the form of an equation, and MR wanted to solve the problem using mixed methods.

Based on the presentation of MR's answers and interview results at the stage of implementing the problem solving plan, a description was obtained that MR implemented the problem solving plan in accordance with the planning stage for solving the questions. Namely making examples, creating mathematical models in the form of equations, eliminating and substituting.

Based on the presentation of MR's interview results at the stage of re-checking the problem solving, a description was obtained that MR was sure of his answer, MR looked again at the answer he wrote, MR knew how to prove or check whether his answer was correct, and MR concluded that the price of 4 notebooks and 2 pencils was 13,000, and the price of 3 notebooks and a pencil costs 9,000, and the price of 5 notebooks and 2 pencils costs 15,500.

3.2.Discussion

Below we will discuss the results of the research previously explained regarding students' SPLDV problem solving profiles in terms of students' learning styles. The discussion can be explained as follows.

1. Visual Learning Style (IN) Subject Problem Solving Profile

At the stage of understanding the question, the visual learning style (IN) subject states in writing on the answer sheet the information known from the question, states the information orally the information understood from the question, explains the information known and is asked about from the question, states that the information from the question is sufficient to answer the question. This shows that students with a visual learning style (IN) can understand the questions given. This is in line with opinionUlfiana (2023) that students who have a visual learning style can write down the information they know and are asked about from the questions in a neat and orderly manner and can explain the information contained in the questions completely. And (Boneva & Mihova, 2011)states that visual people have characteristics, one of which is attention to detail. This means that visual students are careful about what they are doing so that when working on problems, visual students are able to understand the concepts written down by rewriting what they know and asking questions.

At the planning stage of solving visual learning style (IN) subject questions, you want to create an example with the symbols x and y to create a mathematical model in the form of an equation based on what is known from the problem given, then use a combined method (elimination-substitution) to obtain the values of x and y. This is in line with the opinion (Rahmatica. et al, 2022)that students are able to sort information. This is as stated by (Boneva & Mihova, 2011), one of the characteristics of students with a visual learning style is good planning, which allows students with a visual learning style to be able to make good solution plans.

At the stage of implementing the problem solving plan, visual learning style (IN) subjects carry out the problem solving plan in accordance with the problem solving planning

stage. IN's steps at the stage of implementing the problem solving plan are as follows: (1) Make an example with x and y symbols to create a mathematical model in the form of an equation and write it on the answer sheet; (2) Create a mathematical model in the form of an equation based on what is known and write it on the answer sheet; (3) Create two new equations by multiplying equation (1) by number 1 and equation (2) by number 2 to obtain a new equation. From the two new equations IN eliminates the variable y by subtracting the two new equations to obtain the value of the variable x, and write it on the answer sheet; (4) Substitute the value of the variable x into equation (2) to obtain the y value and write it on the answer sheet.

At the stage of re-checking the problem solving, the visual learning style (IN) subject is sure of the answer by looking back at the written answer, does not re-check the answer because he does not understand how to prove or check whether the answer is correct, and can conclude the final result obtained. This is in line with opinion(Satria S, U, & Budiono, 2022) that subjects with a visual learning style can only go through three stages, namely the stage of understanding the problem, making a problem solving plan, and carrying out problem solving, in the fourth stage, namely checking again. The subject only works according to the plan he has planned without double-checking the steps he has taken.

2. Problem Solving Profile for Auditory Learning Style Subjects (MA)

At the stage of understanding the question, the auditory learning style (MA) subject verbally states the information understood from the question, states the information asked for in the question, and states that the information from the question is sufficient to answer the question. This shows that MA can understand the questions given. This is in line with the opinion of Ulfiana (2023) that students can explain well and completely the information they know and are asked about from the question, however, they do not write it on the answer sheet.

At the planning stage for solving problems in the auditory learning style (MA) subject, you want to make an example with x and y symbols to create a mathematical model in the form of an equation and use a combined method (elimination-substitution) to solve the problem. This is in line with opinion (Rahmatica. et al, 2022) that students are able to sort information.

At the stage of implementing the problem-solving plan, auditory learning style (MA) subjects carry out the problem-solving plan in accordance with the problem-solving planning stage. MA's steps at the stage of implementing the problem-solving plan are as follows: (1) Make an example with x and y symbols and write them on the answer sheet; (2) Create a mathematical model in the form of an equation based on information from the question, and write it on the answer sheet; (3) Create two new equations by multiplying equation (1) by number 1 and equation (2) by number 2 to obtain a new equation. From the two new equations MA eliminates the variable y by subtracting the two new equations to obtain the value of the variable x, and write it on the answer sheet; (4) Substitute the value of the variable x into equation (2) to obtain the y value and write it on the answer sheet.

At the stage of re-checking the problem solving, the auditory learning style subject (MA) is sure of the answer by looking back at the written answer, (MA) knows how to prove whether the answer is correct by re-checking the answer, and can conclude the final results obtained. This is in line with opinionJannah (2022)in his research stated that when re-checking the answers, students can conclude the answers to the questions given and are confident that the answers they get are correct based on repeated and as good re-checking as possible.

3. Problem Solving Profile for Kinesthetic Learning Style (MR) Subjects

At the stage of understanding the problem, the kinesthetic learning style (MR) subject verbally states the information understood from the problem, states the information asked for from the question, and states that the information from the question is sufficient to answer the question. This shows that MR can understand the questions given. This is in line with the opinion of Ulfiana (2023) that students are able to explain well and completely the information they know and are asked about from the question, however, they do not write it on the answer sheet.

At the planning stage for solving problems in the kinesthetic learning style (MR) subject, you want to make an example with x and y symbols to create a mathematical model in the form of an equation and use a combined method (elimination-substitution) to solve the problem. This is in line with the opinion (Rahmatika. et al., 2022) that students are able to sort information.

At the stage of implementing the problem-solving plan, kinesthetic learning style (MR) subjects carry out the problem-solving plan in accordance with the problem solving planning stage. MR's steps at the stage of implementing the problem-solving plan are as follows: (1) Make an example with x and y symbols and write them on the answer sheet; (2) Create a mathematical model in the form of an equation based on information from the question, and write it on the answer sheet; (3) Create two new equations by multiplying equation (1) by number 1 and equation (2) by number 2 to obtain a new equation. From the two new equations MR eliminates the variable y by subtracting the two new equations to obtain the value of the variable x, and write it on the answer sheet; (4) Substitute the value of the variable x into equation (2) to obtain the y value and write it on the answer sheet.

At the stage of re-checking the problem solving, the kinesthetic learning style subject (MR) is sure of the answer by looking back at the written answer, (MR) knows how to prove whether the answer is correct by re-checking the answer, and can conclude the final result obtained.This is in line with opinion Jannah (2022)in his research stated that when re-checking the answers, students can conclude the answers to the questions given and are confident that the answers they get are correct based on repeated and as good re-checking as possible.

4. CONCLUSION

Based on the results of research conducted by researchers regarding the Profile of Solving Problems for Systems of Linear Equations in Two Variables for MTs Al-Khairat Tomini Students Based on Student Learning Styles. So the following conclusions are drawn:

1.Based on the research results, visual learning style problem solving can state orally or in writing the information contained in the problem given, the subject can prepare a problem-solving plan by making examples to create a mathematical model in the form of an equation and solve it using a combined method, the subject carries out the plan in accordance with the problem-solving plan, and the subject did not recheck the problem solving because he did not understand how.

2.Based on the results of the research, the problem-solving subject in the auditory learning style can verbally state the information contained in the problem given, the subject can prepare a problem-solving plan by making examples to create a mathematical model in the form of an equation and solve it using a combined method, the subject carries out the problem-solving plan according to the problem solving plan, and the subject can check the solution again.

3. Based on the research results, the kinesthetic learning style problem solving subject can verbally state the information contained in the problem given, the subject can prepare a problem-solving plan by making an example to create a mathematical model in the form of an equation and solve it using a combined method, the subject carries out the plan problem solving is in accordance with the problem-solving plan, and the subject can check the solution again.

Suggestions for further research based on the conclusions that have been presented can utilize the results of this research with the aim of being able to use them in the learning process well.

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THE EFFECTIVENESS OF HOTS-ORIENTED LEARNING ON ACHIEVEMENT OF STUDENT HOTS

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ABSTRACT

This research is motivated by the findings regarding the difficulties experienced by students in solving combinatorial problems as an indication of weak High Order Thinking Skills (HOTS) students. The reason is that the lecture process has not facilitated active and interactive student involvement, where the lecture process is dominated by lecturers through the lecture method. Lecturers' formative and summative assessments are mostly because they only access understanding and mastery of material, are not contextual, and have not facilitated student HOTS achievement. This study aims to improve student HOTS through the application of HOTS-oriented learning. The HOTS-oriented learning components in this study include HOTS-based strategies and models, media, and assessments. The type of research used is a quasi-experimental study with a one group pretest-posttest design. The sample for this research was 17 students taking discrete mathematics courses for the 2022/2023 Academic Year. The data obtained were analyzed descriptively in the form of mean, standard deviation, and n-gain and inferential analysis using the one-way Multivariate Analysis of Variance (MANOVA) test. The results showed that students' HOTS experienced an increase after applying HOTS-oriented learning in the four aspects of the skills assessed, namely the skills of analyzing, evaluating, and creating; problem solving skills; creative thinking skills, and critical thinking skills, with an average increase in the medium criteria. Learning that is applied effectively to student HOTS achievement.

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1. INTRODUCTION

As individuals who are projected to become educators or teachers of mathematics subjects, mathematics education students need to be equipped with various competencies that are qualified and in line with the needs of the times. One of the important competencies that must be provided to mathematics education students is professional competence. By having professional competence, students will later become teachers who are competent in building and developing good and effective learning processes so that they can produce smart and skilled students and quality education (Borg, 2018; Retnawati et al., 2018; Zeng, 2023).

It is not enough for prospective mathematics teachers to just master the material and mathematical concepts that will be taught to students, it is also necessary to master thinking skills and mathematical skills in studying and solving mathematical problems that are non-routine and complex in nature which must be passed on to students. . The thinking skills in question are thinking skills that are aligned with the needs of the 21st century, namely High Order Thinking Skills (HOTS) (Hobri et al., 2018; Zohar & Cohen, 2016). By having HOTS, students can learn better, are able to develop more perfect performance, can reduce weaknesses in their learning, and can control information and solve problems in everyday life (Ahmad et al., 2018).

Several literatures identify various student skills that are categorized as higher-order thinking. Following are some of the HOTS skills, namely critical thinking, creative thinking, problem solving, and decision making (Singh et al., 2017), logical, reflective thinking, and metacognition (Zohar & Barzilai, 2015), science process skills (Afolabi & Akinbobola, 2010), argument skills (Kathpalia & See, 2016) as well as the skills to analyze, evaluate, and create (Watson, 2019). In this paper, HOTS is limited to (1) revised Bloom's taxonomy, namely analyzing, evaluating, and creating; (2) problem solving; (3) creative thinking; and (4) critical thinking.

Each course offered in the Mathematics Education Study Program at the Nineteen November Kolaka University (USN Kolaka) is basically structured in such a way that it is relevant for training student HOTS. However, what is of particular concern in this study is the combinatorial content of discrete mathematics courses. Combinatorial material is one of the vehicles to train students in HOTS (Lockwood, 2013). Combinatorial mathematics includes essential material for students to master because it trains students to reason, think critically and creatively, and solve problems (Salavatinejad et al., 2021).

The expected benefits of learning combinatorial mathematics are HOTS achievements for students. However, expectations have not matched reality. From the results of the assessments and interviews, it was found that students had difficulties in solving combinatorial problems that required high-order thinking. Similar findings were also reported by several previous researchers, namely students' ability to solve combinatorial problems was lower than the level of complexity of the questions given due to students' low HOTS (Rahayuningsih, 2016; Uripno & Rosyidi, 2019; Dwinata, 2019).

Given the importance of HOTS, the problem of weak HOTS for students is a serious problem that must be addressed. Notes from lecture reflection, namely the lecture process has not facilitated active and interactive student involvement, where the lecture process is dominated by lecturers through the lecture method. Most of the lecturers' formative and summative assessments are because they only access understanding and mastery of the material, are not contextual, and have not facilitated student HOTS achievement. These findings are thought to be the main cause of students' low HOTS.

Based on this description, HOTS-oriented learning transformation is deemed necessary to be carried out. The use of strategies, models, assessments, and other tools in

learning needs to be focused on achieving HOTS without forgetting lower-level thinking skills. Some relevant research results, namely: (1) the average HOTS score of students increases after experiencing HOTS-based learning on four skills namely problem solving, critical thinking, creative thinking, and analytical thinking (Kwangmuang et al., 2021); (2) HOTS learning can make students think systematically, learn to analyze a problem from various aspects, educate students to be confident, and improve critical and creative thinking skills (Hidayati, 2017); and (3) Several innovative active and constructive learning models and strategies have been proven to increase student HOTS (Hwang et al., 2018; Mahanal, 2019; Prahani et al., 2020; Zubaidah et al., 2015).

From previous research, no one has examined the effectiveness of HOTS-oriented learning that integrates strategies, models, media, and assessments at the higher education level, especially in combinatorial content. Therefore this study focuses on the application of HOTS-oriented combinatorial learning and then measures its effect on student HOTS achievement. HOTS-oriented learning in question is learning that integrates the concepts of blended learning and problem-based learning, media in the form of student activity sheets, and HOTS-based assessment sheets. The aim is to determine the effectiveness of learning on increasing student HOTS.

2. METHOD

This research is included in the type of quantitative research. To find out the effectiveness of HOTS-oriented combinatorial learning on student HOTS achievement, a one group pretest-posttest design was applied. This research was carried out at the Mathematics Education Study Program, Faculty of Teacher Training and Education USN Kolaka. The sample for this research was students who took the Discrete Mathematics course for the 2022/2023 Academic Year, consisting of 17 people. An initial test (pretest) was given to participants before applying HOTS-oriented learning. The aim is to access students' initial HOTS before treatment on the four thinking skills, namely (1) analyze, evaluate, and create; (2) problem solving; (3) creative thinking; and (4) critical thinking.

Next, HOTS-oriented learning is carried out with the learning concept presented in Figure 1. Learning activities are divided into three main parts, namely input, process, and output. Activities in the input section are pre-learning activities, namely (1) determining the roles of lecturers and students by paying attention to aspects of student involvement; (2) preparing and incorporating content into PPT by paying attention to aspects of differentiation, designing LKM, compiling HOTS-based instruments, as well as defining and preparing other tools that will support the face-to-face learning process such as manila paper, origami paper, markers, scissors, and etc; and (3) setting up an online learning management system using a combination of the Google Classroom and WA group applications.

In the process section, learning activities are carried out that integrate the concepts of blended learning and problem-based learning. Before entering class, students first access and study the material that has been prepared on Google Classroom and discuss with colleagues to build their initial knowledge and thinking skills. Learning is then continued face-to-face using a problem-based learning model with 13 phases as shown in Figure 1. The learning activities take place over four meetings with the scope of material: the basics of counting, permutations and combinations, the pigeonhole principle, and discrete probability. After the learning activities ended, in the fifth meeting a posttest was carried out.

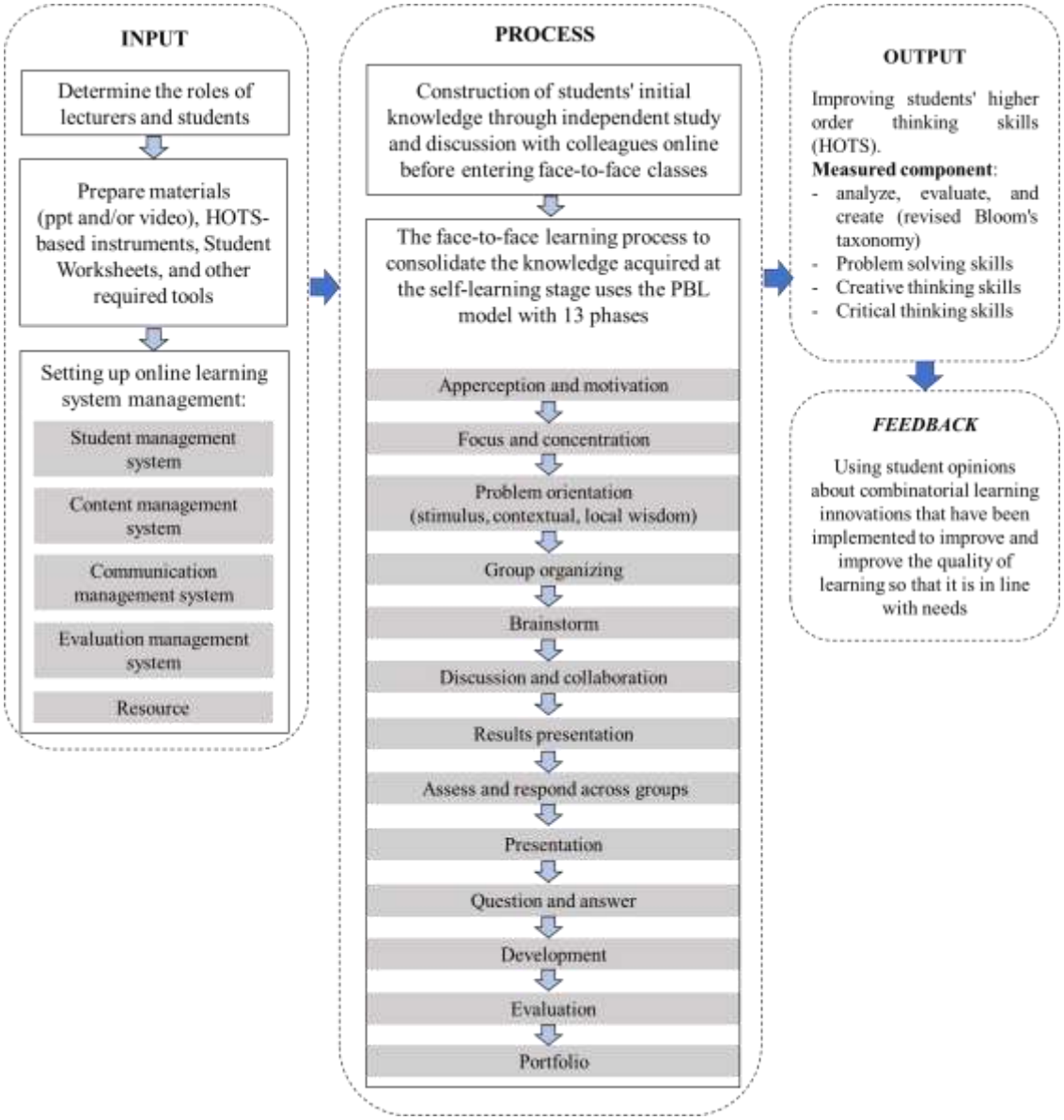


Figure 1. HOTS-oriented learning framework

The instruments in this study consisted of lecturer activity observation sheets, student activity observation sheets, and the HOTS test (pretest and posttest). For the observation sheet using a Likert scale (five criteria). For the HOTS test, there are four components of thinking skills that are measured by each assessment rubric, namely: (1) analyze, evaluate, and create; (2) problem solving; (3) think creatively; and (4) critical thinking (Mahanal, 2019).

The data obtained from the observation sheets were analyzed and presented in percentage form. Pretest and posttest data were analyzed descriptively and inferentially. Descriptive analysis was intended to describe HOTS students before and after treatment in the form of mean and standard deviation. To calculate the increase in HOTS between before and after treatment, a normalized gain (n-gain) analysis was performed. The improvement criteria based on the n-gain value are presented in Table 1.

Table 1. Criteria for improvement based on the n-gain value

Intervals	Criteria
$0.70 - 1.00$	Tall
$0.30 - 0.69$	Middle
$0.00 - 0.29$	Low

Source: (Arbain & Hali, 2021)

The inferential analysis is intended to provide statistical justification regarding the increase in student HOTS that occurs. The test that was carried out was the one-way Multivariate Analysis of Variance (MANOVA) test with the pretest and posttest data groups as fixed factors and four thinking skills: (1) analyze, evaluate, create; (2) problem solving; (3) creative thinking; and (4) critical thinking as the dependent variable. The assumption test as a preliminary test is included before the MANOVA test, namely the multivariate normality test with the Chi-Square Plot and the covariance matrix homogeneity test with Box's M test (Rusli et al., 2018). All analyzes were performed using SPSS software. The level of statistical significance was set at $\alpha = 0.05$. Learning is said to be effective towards achieving HOTS, if it meet two criteria: (1) the implementation of learning activities both from student activities and lecturer activities obtains a minimum percentage of 80%; and (2) Sig. the output of the MANOVA test is less than the significance level of $\alpha = 0.05$.

3. RESULTS AND DISCUSSION

3.1. Results

The learning activities were carried out in four meetings. The results of the analysis of the implementation of learning data, namely the observation sheet data of student activities and lecturer activities are presented in Table 2.

Table 2. Description of learning implementation data

Meeting	Student Activity (%)	Lecturer Activity (%)
I	81.33	82.67
II	85.33	84.00
III	90.67	88.00
IV	90.67	90.67
Average	87.00	86.33

Based on Table 2, it was found that the implementation of learning tended to increase student activity and lecturer activity at each meeting with an average student activity carried out of 87.00% and an average lecturer activity of 86.33%.

The results of the descriptive analysis of student HOTS data before experiencing learning innovation (pretest data) and after experiencing learning innovation (posttest data) are presented respectively in Table 3 and Table 4.

Table 3. Description of pretest data

Deskription	C4, C5, C6 (Revised Bloom's Taxonomy)	Problem Solving Skills	Creative Thingking Skills	Critical Thingking Skills
Respondents	17	17	17	17
Minimum	26.92	27.78	35.56	20.00

Maximum	69.23	69.44	71.11	66.67
Means	50.45	47.06	49.54	47.84
Standard deviation	10.17	12.32	10.91	12.96

Table 4. Description of posttest data

Deskription	C4, C5, C6 (Revised Bloom's Taxonomy)	Problrm Solving Skills	Creative Thingking Skills	Critical Thingking Skills
Respondents	17	17	17	17
Minimum	55.56	55.00	57.33	60.00
Maximum	91.11	81.67	85.33	92.00
Means	73.07	67.06	70.27	73.18
Standard deviation	10.88	8.05	8.90	9.36

Table 3 informs that before HOTS-oriented learning was implemented, students' HOTS achievements were not yet at an encouraging level. The average HOTS of students in the four skills assessed is only in the range of 50 on a scale of 100. The average score obtained by students on the four thinking skills, namely analyzing, evaluating, and creating is 50.45, problem-solving is 47.06, creative thinking at 49.54, and critical thinking at 47.84.

Table 4 provides information that after applying HOTS-oriented learning, there was an increase in students' HOTS scores in the four thinking skills assessed with an average score of analyzing, evaluating, and creating at 73.07, problem solving at 67.06, creative thinking at 70.27, and critical thinking of 73.18. The increase in the HOTS value is then analyzed by n-gain, then a grouping of improvement criteria is made based on the n-gain value. Description of n-gain values and grouping of improvement criteria based on n-gain values are presented in Table 5 and Table 6 respectively.

Table 5. Description of n-gain value

Deskription	n-gain value			
	C4, C5, C6 (Revised Bloom)	Problem Solving	Creative Thinking	Critical Thinking
Respondents	17	17	17	17
Minimum	0.29	0.18	0.30	0.23
Maximum	0.79	0.46	0.53	0.76
Means	0.47	0.38	0.42	0.49
Standard deviation	0.15	0.06	0.08	0.13

Table 6. The improvement criterion is based on the n-gain value

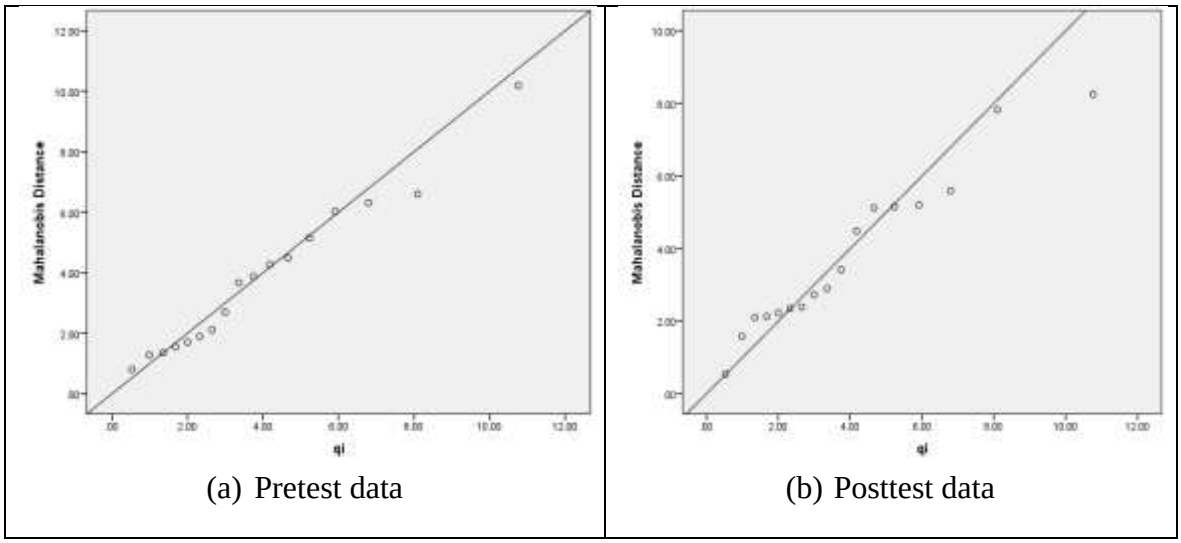
Intervals	Criteria	Number of Students			
		C4, C5, C6	Problem Solving	Creative Thinking	Critical Thinking
$0.70 - 1.00$	Tall	2	0	0	2
$0.30 - 0.69$	Middle	14	16	17	14
$0.00 - 0.29$	Low	1	1	0	1

By referring to the description of the n-gain value in Table 5 and the improvement criteria in Table 6, information is obtained that students experience an increase in the scores of the four thinking skills being assessed, with a description: (1) in the skills of analyzing, evaluating, and creating 2 people experienced an increase in the high category, 14 people in

the medium category, and 1 person in the low category; (2) in problem solving skills the increase that occurred was only in the medium and low categories, namely as many as 16 people in the medium category and 1 person in the low category; (3) on creative thinking skills, all participants, namely as many as 17 people, experienced an increase in the moderate category; and (4) on critical thinking skills, students who experienced an increase in the high category were 2 people, 14 students in the medium category, and 1 person in the low category.

Based on the results of the descriptive analysis above, a descriptive conclusion was obtained that students' HOTS scores increased after learning activities were carried out by applying the HOTS-oriented learning concept. To get statistical justification and find out the significant increase in the HOTS value, a MANOVA test is carried out by first carrying out an assumption test in the form of (1) multivariate normality test using Chi-Square plots with the Mahalanobis distance, and (2) test the homogeneity of the covariance matrix using Box's M test.

Based on the calculation results according to the steps for determining the mahalonobis distance and the Chi-Square (qi) value of the data in this study, a scatter-plot was obtained between the mahalonobis distance and qi, which is presented in Figure 2.



(a) Pretest data (b) Posttest data

Figure 2. Chi-Square plots with the Mahalanobis distance for (a) pretest data, (b) posttest data

The scatter-plot results in Figure 2 shows that the Chi-Square plot and the Mahalonobis distance tend to form a straight line on both the pretest and posttest data, which means that the research data is normally multivariately distributed. This conclusion is strengthened by a very strong correlation between the Chi-Square value and the mahalanobis distance, which is 0.989 for the pretest data and 0.976 for the posttest data.

The results of the covariance matrix homogeneity test are presented in Table 7. From Table 7, the value of Box's M = 26.285 and F = 2.270 is obtained with a value of Sig. = 0.012. Menurut Hahs-Vaughn, (2016), Box's M test has a high level of accuracy and also has a high sensitivity for small samples, so that the alpha (α) limit can be reduced to 0.001. So, to find out whether the results of the Box's M test are significant or not, that is by comparing the Sig. with a level of α=0.001. Because the value of Sig. = 0.012 is greater than 0.001, the results of the Box's M test are not significant, which means that the research data has a homogeneous covariance matrix.

Table 7. The statistical value of the covariance matrix homogeneity test

Statistics	Statistical Value
Box's M	26.285
F	2.270
df1	10
df2	4895.618
Sig.	0.012

Then a one-way MANOVA test was carried out with a recap of the test results shown in Table 8.

Table 8. The statistical value of the MANOVA test

Statistics	F	Sig.
Wilks' Lambda	10.318	0.000

From Table 8, the statistical value of Wilks' Lambda is obtained, namely $F = 10.318$ with a Sig. $= 0.000$ less than $\alpha = 0.05$. That is, the MANOVA test results are significant. Thus there is a significant difference in students' HOTS scores before and after applying HOTS-oriented learning, In this case, there is an increase in scores after applying HOTS-oriented learning to the four skills assessed, namely analyzing, evaluating, and creating; solution to problem; creative thinking; and think critically.

3.2. Discussion

The HOTS-oriented learning process that integrates the concepts of blended learning and problem-based learning has facilitated students to construct their initial knowledge and skills creatively. Through the learning strategies implemented, students are encouraged to explore content from various sources and discuss with colleagues to build their initial understanding before entering face-to-face classes. So that when entering face-to-face classes, students already have initial knowledge regarding content that is ready to be consolidated and developed in the form of group discussions, presenting work results, question and answer, mutual responses, and presentations. It was proven that starting from the first meeting of face-to-face learning, students were very active in discussing, asking, responding and expressing opinions with an active percentage of 81.33% and increasing in subsequent meetings to reach a percentage of 90.67% in the fourth meeting. Likewise, teaching activities experienced an increase from 82.67% implementation of learning in the first meeting up to 90.67% in the fourth meeting. This shows that the learning process has been carried out well and has exceeded the standards set, namely the minimum implementation of learning is 80%.

Relevant to the presentation of the results of this research, several previous studies stated: (1) blended learning is useful in helping students to develop better in the learning process, according to learning styles and learning preferences, providing realistic practical opportunities for educators and participants students for independent learning, as well as involving students in interactive experiences (Arifin & Abduh, 2021; Meilani et al., 2022); and (2) problem-based learning is useful in fostering enthusiasm for learning because students feel directly connected to real life, sparking student activity in working together to solve problems, and facilitating students to be communicative (Ramadhan, 2021; Aman, 2016; Maryati, 2018).

The increase in student enthusiasm, activeness, collaboration, and communication as captured in the learning activity observation sheet was also followed by increased student achievement in high-level thinking skills. The results of descriptive and inferential analysis have shown that learning that focuses on achieving HOTS has had a significant impact on increasing student HOTS in the four aspects assessed, namely: (1) analyzing, evaluating, and creating; (2) problem solving; (3) creative thinking; and (4) critical thinking. This shows that the application of HOTS-oriented learning is effective for student HOTS achievement.

With HOTS-oriented learning, students are facilitated to practice their abilities in identifying problems, simulating problem situations, comparing problems, and designing problem-solving strategies as well as creating new hypotheses or adjusting the process to get other answers. The HOTS-oriented learning that is implemented provides opportunities for students to develop their abilities in analyzing and linking all existing information and connecting it with real problems, evaluating events in the problem to determine relevant solution strategies for each event, then creating models for each event and combining them to solve problems. Apart from that, students also become more critical and creative, where every solution to the problem given is accompanied by rational arguments and rich in ideas.

The findings in this research support the results of previous research which stated that HOTS-based learning is beneficial for the growth and development of students' skills in problem-solving, critical thinking, creative thinking and analytical thinking (Kwangmuang et al., 2021); make students think systematically, learn to analyze a problem from various aspects, educate students to be confident, and improve critical and creative thinking skills (Hidayati, 2017). Several innovative active and constructive learning models and strategies have been proven to increase student HOTS (Hwang et al., 2018; Mahanal, 2019; Prahani et al., 2020; Zubaidah et al., 2015).

The results of this research have theoretical implications that thinking skills are closely related to learning, where HOTS students can grow and develop through appropriate learning. HOTS can develop well if it is carried out deliberately and planned through the application of strategies and learning models that actively involve students (Yee et al., 2015). A similar opinion was expressed by Singh et al., (2017) that HOTS can be developed through appropriate learning models and learning environments that facilitate the development of students' thinking as well as persistence, self-monitoring, an open attitude, and a flexible attitude. In this case, the implementation of learning is not solely on the transfer of knowledge or information which ultimately results in low-order thinking but needs to be emphasized on achieving HOTS. In line with this opinion, Mahanal, (2019) suggested that HOTS was triggered by four situations, namely: (1) a certain learning condition that requires a special or specific learning scenario and cannot be used in other learning conditions; (2) thinking skills are no longer considered skills that cannot be changed, but rather a set of knowledge that can be promoted by various factors such as learning strategies, learning environment, and self-motivation; (3) a shift in understanding from a unidisciplinary and linear perspective to an interdisciplinary and interactive perspective; and (4) more specific HOTS such as reasoning, analytical skills, problem-solving, and critical and creative thinking skills.

In this study, in addition to using active learning models and strategies, namely combining the concepts of blended learning and problem-based learning, media integration in the form of student worksheets and HOTS-based assessments which are based on the core of important skills that apply to everyday academic situations, novelty, and includes various test items that require continuous reasoning and are also an important factor in increasing student HOTS. Regular and planned HOTS-oriented learning and assessments bring benefits to students. Students' thinking skills and overall performance improve with the implementation of the HOTS-oriented learning and assessment model. Students learn by

constructing meaning and incorporating new content into their mental representations. Therefore, improving thinking skills, actually also increases knowledge and understanding of content.

4. CONCLUSION

The findings in this study indicate that learning strategies and models and their assessments that are managed intentionally and planned to support the interests of HOTS development bring benefits to increasing student enthusiasm, activeness, collaboration, and communication as well as improving thinking skills in four aspects, namely: (1) analytical skills, evaluate, and create; (2) problem solving skills; (3) creative thinking skills; and (4) critical thinking skills. This means that learning is applied effectively to student HOTS achievement. The HOTS-oriented learning components in this study include strategies and models that combine the concepts of blended learning and problem-based learning, student worksheets and other supporting media, as well as HOTS-based learning assessments. Learning activities run well and smoothly as planned.

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Innovation of Learning Management System in Mathematics Education Study Program as MBKM Supporting Media

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ABSTRACT

The main objective of this research is to produce an LMS that can support synchronous, asynchronous, and blended learning systems, especially in the Mathematics Education study program at Universitas Sembilanbelas November Kolaka (USN Kolaka). This LMS is essential because USN Kolaka currently does not have an independent LMS. At the same time, the existence of an LMS greatly supports the implementation of MBKM, especially in lecture programs outside the University. The LMS that will be created is an open-source-based LMS that also supports the use of the Woocommerce system. Specifically, the course that will be included in the system is the Mathematics Learning Media course. However, this LMS will be developed into an online mathematics learning center throughout Indonesia, starting from elementary school to university level. To develop this LMS requires several stages. The first stage is to analyze what essential materials will be included in the system first. Second, designing or designing the LMS interface and menu layout, including how to deliver the material; the third stage realizes what has been planned. The realization stage consists of product trials, evaluation, and revision. The last stage is the implementation stage. This stage of development is known as the Plompt model. From these stages, an open-source LMS that is suitable for use as an online learning platform is obtained. It can include various lesson materials. Especially for this research, the teaching materials included have also gone through a validation process so that both the material and the media are ready to be used for the teaching and learning process.

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1. INTRODUCTION

The Merdeka Learning Campus policy issued by the Ministry of Education, Culture, Research, and Technology has brought significant changes to the learning process in higher education. Through its programs, students from 3T areas can get the opportunity to study at renowned universities in Indonesia. They can also choose courses outside their study program as they wish. Not only that, the involvement of industry and society in the learning process can provide practical experience for students in preparing themselves to face the world of work.

Based on the MBKM implementation guidebook issued by the Ministry of Education in 2020, there are about eight items in the MBKM program. One of them is student exchange, which is an opportunity to study at another university that may have better facilities and infrastructure than the original campus. Being able to feel the atmosphere of education at a renowned university is a precious experience for students. In addition, this program supports the achievement of IKU 2, IKU 6, and IKU 7 in the university.

In practice, the opportunity to study at another university can be done in two ways: offline and online. For online lectures, of course, the receiving party must have an LMS facility that can help with learning management. However, if the lectures are conducted offline at the receiving campus, the sending campus should also have an LMS to facilitate the departing students. The curriculum structure in each university may be different so there may be compulsory courses at the home university that must be programmed by students but not at the receiving university. In order for students not to be left behind, the compulsory courses must be taken. To facilitate students, a Learning Management System (LMS) is needed.

Therefore, through this opportunity, an LMS will be developed that can later be used for the learning process in the Mathematics Education study program at Universitas Sembilanbelas November Kolaka. This LMS can support the implementation of the independent campus learning program, especially in the Mathematics Education study program. This LMS will provide learning facilities complete with evaluation tools. Furthermore, the LMS that will be developed can be commercialized or paid for outside students who try to access it so that it can provide income for the instructors / lecturers who teach the course. In addition to campus use, the LMS can be developed into an online course for those who need to understand more about math, from elementary school to college level.

Learning Management System (LMS) is a good solution for organizing learning in the network. This LMS can be in the form of web-based or android-based applications. There are many web-based and android-based software that can be used in the network teaching and learning process but not all fall into the LMS category. For example, WhatssApp, Facebook, Instagram and other social media can also be used to teach online but all of them are not LMS (Irfan, 2019)

An LMS at least provides material storage features, group communication features, personal communication, attendance and grade processing features because these features are very supportive of learning management. Some examples of LMS that have these facilities are Schoology, Microsoft Teams, modified goole classroom and Moddle (Ak. Nasrum & Subawo, 2022). All of these LMSs are web-based and are also available in the form of applications on android. Each of these LMSs has its own advantages.

Schoology, whose interface is similar to Facebook, makes it easy for users to understand its use. Even though there is no manual book, this LMS is very easy to use. The features available in it are very helpful in the course of learning well. One feature that is available in schoology but not in other LMS is the involvement of parents in the implementation of learning. Schoology provides a separate feature for parents to monitor

their children's progress in learning. However, the add-in for video conferencing cannot be used for free Schoology (Mashuri & Nasrum, 2020). This feature is needed to support the online learning process.

Furthermore, Microsoft Teams is an online learning platform provided by Microsoft corporation. All the main features required by an LMS are present on this platform. The main advantage is that it has a very large file storage facility for each account which is 1 TB. Another advantage is that it is equipped with communication facilities both in groups and personally, text or voice, video calls or telephone calls, all in one platform. Microsoft Teams is an LMS that has complete features, but unfortunately the quiz-making platform is still very standard as in google forms (A. Nasrum & Subawo, 2021).

Apart from Microsoft, other large companies such as Google Corporation have also developed a platform to help the online learning process, namely Google Classroom. There are also many users of this platform because the platform is free and very easy to use. The features are not as complete as other LMS features, but can be completed by adding features that are also made by Google such as Google Meet, Google Form and Google Drive. The disadvantage of google classrom is that it does not have a private chat feature. There is only a discussion forum so if we want to reprimand students privately then we have to use another application.

These shortcomings can be complemented with an LMS such as moodle. Moodle is an online learning platform that is easily customized according to the user's wishes (amsraidorj & Sambuu, 2013; Soesanto et al., 2022). It has many plugins that allow adding certain features needed. In contrast to all the LMS mentioned above, all these platforms are available in a ready-made form so it is not possible to modify them. If the school has a wordpress-based website then the LMS created using moodle can be directly integrated.

Some features on the LMS that are considered important such as the assignment, feedback and quiz features are all on (Lakin, 2018) moodle. In addition, supporting features in lectures such as the integration of learning videos, the availability of discussion forums, private chats and content delivery are also very supportive in this LMS (Herayanti et al., 2018).

In this research we want to use moodle in developing the LMS. Moodle was chosen because it is already very popular in use. Although it is popular out there, students in Kolaka city, especially USN Kolaka students, are mostly unfamiliar with this LMS. In addition, moodle is very easy to use both using a laptop and using a smartphone. No less important is that moodle is effectively used for distance learning management (Pratiwi, 2022).

2. METHOD

This research falls into the type of development research (R&D). The development model used is the Plompt model. This model consists of four stages, namely initial investigation, design stage, realization, (test, evaluation and revision), and implementation stage. At the initial investigation stage, we will find out which mathematics courses are also taught in most study programs. This course will first be incorporated into the LMS system to serve as a trial course. In addition, we will find out the scope of material taught in each study program so that later it can be adjusted. The second is the design stage. In the design stage, the procedure for delivering lectures is designed. Lecture teaching materials can be in the form of video tutorials or video explanations of material. The process of delivering material using video is also designed in such a way as to be more interesting than classroom delivery. In addition, in this stage the LMS display is designed, the LMS plan to be used is Moodle. The third stage realizes the results of the design/design. This realization is the realization of making an LMS with complete material in it. After everything is complete, a

small group trial is carried out and then evaluated. There may be some shortcomings that need to be corrected. The fourth stage is the stage of implementing lectures using the LMS.

The research instrument used is a learning media validation instrument developed based on the Learning Object Review Instrument (LORI). There is no need for material validation because the material is taught by lecturers who have experience in their fields. For media validators taken from lecturers who are experienced in the field of learning media and lecturers from Information Systems who understand the website. The measurement scale in this instrument uses a semantic difference scale. The results obtained were then analyzed using the average score of the validators whose numbers were consulted with the classification table (Eko Putro Widyoko, 2012)

3. RESULTS AND DISCUSSION

3.1. Initial Investigation

In the odd semester of the 2022/2023 academic year, there was one student of the USN Kolaka Mathematics Education study program who participated in MBKM activities. The student took courses at IKIP Budi Utomo Malang. Due to differences in the curriculum at USN Kolaka, there are several compulsory courses at USN Kolaka that cannot be programmed at IKIP Budi Utomo. While these courses also cannot be converted from several courses taken at IKIP. Therefore, these students must take compulsory courses at USN Kolaka using the LMS.

Until now, the LMS of Universitas Sembilanbelas November Kolaka does not exist. Lecturers who provide distance learning facilities use free LMS such as google classroom. Not bad, but as an educational institution it should have independent supporting facilities to improve the quality of education.

Based on the results of interviews with the head of the mathematics education study program, information was obtained that the LMS is really needed to support the learning process. LMS is needed as a place to store teaching materials for lecturers. Teaching materials that are already available on the LMS will be easily accessed by students so that the transfer of teaching materials becomes more efficient. Currently, many lecturers have activities outside the campus such as being assessors in schools, ppg assessors and others. Therefore, LMS is needed for lecturers who do not have time to carry out offline lectures on campus.

3.2 Design Stages

The design stage started with thinking about the webhosting that would be used to install Moodle. It was also thinking of an appropriate name for the LMS. Actually, this LMS should be under the faculty or study program website. While the website of the Faculty of Teacher Training and Education is currently not active. To activate the faculty website affiliated with the university website, it must be communicated with UPT TIK. Moreover, if you want to install a certain LMS, everything must be under the control of UPT TIK.

This research is limited by time so that to streamline time, it is designed to make a stand-alone faculty website with the name https://fkipusn.ac.id. This web plan is made to facilitate control in making LMS. In order for the research to run smoothly, the making of the LMS must be fully controlled by the researcher. After the faculty website is finished, then think about the name of the LMS that will be used. Because USN Kolaka is located in the land of Mekongga, the term SIKONGGA (Online Lecture Information System for the Generation of Reliable Teachers) was taken as the name of the LMS. The Moodle LMS will be installed at https://sikongga.fkipusn.ac.id.

The course that will be included as an example is the numerical methods course. The teaching material plan used is a module made by the lecturer, video explanation of the material, exercises and assignments.

3.3 Realisation, (test, evaluation dan revision)

As planned, the Faculty website was finally created. From the website, a subdomain was created with the name https://sikongga.fkipusn.ac.id. It is on this subdomain that the Moodle LMS is installed. The display on the login page can be seen in Figure 1.

Figure 1. SIKONGGA Login Page

After the LMS is installed, some initial settings are made such as inserting the absence plugin and setting the mobile version. This needs to be done because by default the latest version of Moodle does not have an attendance feature and the mobile feature is also not active. After these settings are completed, it is continued by entering the names of students who will be used as test subjects into the LMS. Next, a course was created, namely the numerical methods course. After the course is created, students who have registered in the LMS are re-entered into the course/courses that have been created. After that, the material is entered along with the required exercise questions.

After all was completed, a trial was conducted on 3 students. The trial of using the LMS on mobile phones was carried out because all students have mobile devices. In the implementation of this trial there are only two things that need to be revised, namely:
No notification appears on the student's cellphone when the lecturer sends a message. The assignment upload feature does not appear when given an assignment.

For message notification settings, it must be set again in the mobile version through the use account, preferences, messages icon and activate notifications in the mobile version as shown in the figure.

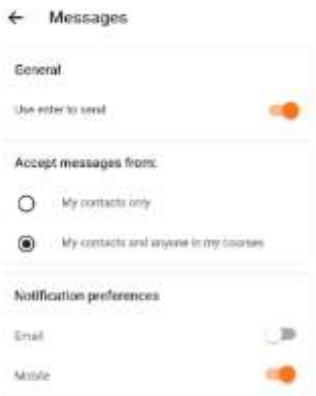

Figure 2. Message notification settings on mobile phones

After activating the feature, a notification will appear on the cellphone if a message is sent or entered. Next is the task upload feature. This feature may not be active if the submission permission in the assignment section is activated. Actually this feature is very well used to limit the time of sending assignments. However, if the time on the lecturer's device and the time on the student's device are different, this could be a problem. Especially if the time zone setting on the moodle device which by default is the United States has not been changed, it is likely to cause problems. To prevent this, this feature should not be enabled.

Figure 3. Task submission settings

Furthermore, testing and checking the function of all LMS supporting features such as the Attendance feature, delivery of teaching materials, quizzes / exercises and assessment features. All these features can function properly during the trial process so that after all the sides that are considered problematic are revised, proceed to the implementation stage.

3.4 Implementation stage

3.4.1 Attendance Feature

One of the features in the LMS that must be available is attendance. In moodle version 4.2.2, attendance is not installed by default. To activate this feature, you need to download the attendance plugin at https://moodle.org/plugins/. Once installed, the new attendance feature can be used. Lecture attendance can be done manually by lecturers for each course schedule. However, students can also do their own attendance only during lecture hours. Outside of those hours, students cannot take attendance.

Absences in Moodle can be exported into an excel file to see a recap of student attendance. In addition, the export results can actually also be used for administrative reports if needed. The results of the attendance recap in moodle display the number of attendances, permits, absent or late including attendance presentations. An example of an absence recap can be seen in the picture.

	Course	Metode Numerik											
	Group	All participants											
No	Name	12 Sep 2023	19 Sep 2023	26 Sep 2023	3 Oct 2023	10 Oct 2023	17 Oct 2023	P	L	E	A	Taken sessions	Points	Percentage
1	arjunal arjunal	User enro	←	←	P (2/2)	P (2/2)	P (2/2)	3	0	0	0	3	6 / 6	100
2	rosalia dalima rao	User enro	←	P (2/2)	P (2/2)	A (0/2)	P (2/2)	3	0	0	1	4	6 / 8	75
3	NUR DAWIA	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	6	0	0	0	6	12 / 12	100
4	NUR FAJRIANI	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	6	0	0	0	6	12 / 12	100
5	fina lia	User enro	←	P (2/2)	P (2/2)	A (0/2)	P (2/2)	3	0	0	1	4	6 / 8	75
6	FAIRUN NISA	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	6	0	0	0	6	12 / 12	100
7	ANDI DWI NURAFNI	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	6	0	0	0	6	12 / 12	100
8	WINDI SAPUTRI ODE	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	6	0	0	0	6	12 / 12	100
9	AISYAH DYAH AYU PRAVITASARI	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	P (2/2)	6	0	0	0	6	12 / 12	100

Figure 4. Printout of attendance list to excel spreadsheet

3.4.2 Teaching Material Delivery Features

Teaching materials are provided in the form of modules and videos. The module is a pdf file that has been uploaded to the drive. To enter teaching materials into moodle, you can use the link from the file. Both modules and pdfs are very easy for students to access. Apart from that, moodel also provides a "book" feature that can be used to create online books in the system. This facility allows students to read books online, including printing books both as a whole and by chapter.

Figure 5. Book features in Moodle

3.4.3 Quiz Feature

In the latest moodle version 4.2.2 there are many quiz options that can be used to create questions. These options include: Multiple Choice, True/False, Matching, Short Answer, Numerical, Essay, Calculated, Calculated Multichoice, Calculated, Simple, Drag and Drop Intro Text, Drag and Drop Markers, Drag and Drop onto image, Embedded answer, Random Short-Answer Matching, Select Missing Words. In addition, there is also an "Assignment" feature that can be used to give assignments to students. This feature can be used to provide assignments that can be uploaded to the system. The settings are also flexible so that it can accept various kinds of files, including in this case text.

In this research, the quiz types used are Multiple Choice one answer choice, multiple choice more than one answer choice, true/false and numerical. The use of all these quiz types did not experience any problems. Everything worked as it should.

For the assignment feature, students are asked to send files to the system. They can send in the form of pdf files or in the form of images. However, sending files like this will eventually make the storage capacity full. In the implementation of research, files sent to the system, both pdf and images, cannot be checked directly on a laptop or cellphone. To check student assignments that have been deposited, they must be downloaded first. Most likely Moodle version 4.2.2 is not supported by pdf and jpg readers. But it is also possible that the pdf and jpg reader feature has not been activated, this has not been identified. To get around this, students can upload their work using the link feature. The assignment file is uploaded to each student's drive. They just send the link of the file to be checked. Through this method, the assignment file can be checked immediately without having to download the file. In

addition to making it easier to check, it also does not burden the system due to the reduction of storage.

3.4.4 Assessment Features

The assessment feature in Moodle works very well. The categories to be assessed can be determined by yourself including the presentation grade. Not only that, the setting of letter grades can also be set in the moodle assessment. Moodle provides letter grading but lecturers can change the grading system according to what is applicable on campus.

a. Arrangement of assessed aspects *b. Font Grade Setting*

Figure 6. The assessment feature can set the aspects that are assessed and also the letter description can be adjusted.

3.4.5 Communication Features

Moodle has a mobile version on android. With this mobile version, moodle can be used to communicate like other communication tools such as WhatsApp. It's just that its capabilities are not as capable as the WhatsApp application. But if only to be used for sending text messages, then the communication features in moodle are sufficient. With the mobile version of moodle, lecturers can send messages to students and vice versa. If someone sends a message, then on the recipient's cellphone there will be a notification like in the WhatsApp application. However, the shortcomings in this communication feature cannot include attachments such as files, images or others.

4. CONCLUSION

The features of moodle are unquestionable in the distance learning process. The online learning platform using moodle produced in this research fulfills all the criteria of a complete LMS. All features function well and are easy to use. There is a learning flow feature in moodle that might be used to organize the course of lectures. This feature was not used in this research. It will be studied in the next research topic.

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