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The Effectiveness of Mathematics Learning in HOTS-Based Student Mathematics Learning Planning

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Abstract

The lesson plan is very important to be mastered by the teacher to be able to carry out learning in the classroom to be directed. The lesson plan also contains a question instrument as an assessment of the achievement of learning indicators. The questions compiled must contain high-level thinking-based questions in this 4.0 century. However, in reality, many teachers have difficulty compiling lesson plans with high-level thinking questions. Student teacher candidates also have not been able to design high-level question-based questions. This study aims to see the effectiveness of mathematical literacy in planning student mathematics learning based on HOTS. This research is qualitative research using research methods in the form of data analysis of research results about HOTs that have been designed, interviews, and documentation. The results of this study indicate that the average value of students in planning HOTs-based mathematics learning is 85.7%. Then based on the HOTs-based learning planning that has been designed, 77.8% of students have been able to design questions and their answers by applying questions in everyday life and designing open-ended questions.

Keywords
Effectiveness; learning planning; HOTs

I. Introduction

Education is a very important human need because education has a duty to prepare Human Resources (HR) for the development of the nation and state (Pradana et al, 2020). According to Astuti et al (2019) Education is an obligation of every human being that must be pursued to hold responsibilities and try to produce progress in knowledge and experience for the lives of every individual. Education is one of the efforts to improve the ability of human intelligence, thus he is able to improve the quality of his life (Saleh and Mujahiddin, 2020). Education is expected to be able to answer all the challenges of the times and be able to foster national generations, so that people become reliable and of high quality, with strong characteristics, clear identities and able to deal with current and future problems (Azhar, 2018). Education and skills are the main keys in gaining social status in community life (Lubis et al, 2019).

The knowledge possessed by students is expected not only to focus on learning knowledge but to general knowledge and it is hoped that they are also able to apply lessons in everyday life. According to(Retnawati, 2015)Teachers have difficulties in planning lessons, planning lessons, scheduling attitude assessments, classifying knowledge and skills in preparing assessment tools, limiting learning implementation time, difficulties related to learning tools, and difficulties in student involvement. Not only a complex scoring system and report generation, but also a long time. Besides that, according to(Hasrin Lamote, 2017)state thatdifficultyteachers prepare lesson plans in terms of time allocation, method, origin of learning, teaching and learning activities, &

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assessment.According to(Abdullah, 2015)prospective mathematics teacher students have not really become professional mathematics teachers. There are at least three components that must be mastered by prospective mathematics teacher students to become professional mathematics teacher candidates, namely professional knowledge, professional practice, and professional attitude. Professional knowledge is professional knowledge which consists of knowledge of mathematical material/content, learning theory (approach/model/learning method/strategy), curriculum, and assessment.

Assessment or assessment instrument according to research (Retnawati, 2015)and(Hasrin Lamote, 2017)namely compiling the items of the question. Where, the questions in the latest curriculum must be guided by HOTS-based questions. According to(Saragih et al., 2021)that the current learning paradigm makes a change from the lecturer as the center of attention (lecturer centered learning) to become student oriented (student centered learning) so that an effective and conducive learning atmosphere is built for the creation of changes in behavior and better student competencies. Thus, students are required to be able to compose their own learning tools. According to(Fatimah & Amam, 2018)that RPP is a face-to-face learning activity plan for one or more meetings which is developed from the syllabus to direct student learning activities in an effort to achieve basic competencies (KD).

High Order Thinking Skill(higher order thinking skills) so far have not achieved maximum results. According to(Saraswati & Agustika, 2020)HOTs are kthinking skills of students who can not only remember, but also can develop ideas. Based on the results of previous student learning, students do not have the ability to think high. This can be seen in student learning outcomes about the design of mathematical problems. Many students are still unable to give math assignments in their daily life, and they are unable to structure questions with multiple correct answers. Students still ask questions with ordinary questions. According to(Nuriyatin & Widadah, 2017)teacher candidates cannot ask high-level questions, because only 5% of teacher candidates design high-level questions and answers.According to(Saraswati & Agustika, 2020)the process/forming of students' mathematical sentences and the low number of students in answering analytical questions are obstacles experienced by students. Besides that,(Maryani & Martaningsih, 2020)also mentioned that analyzing items and planning HOTs questions were obstacles faced by teachers in schools.(Rohim, 2019)also explained that HOTs is a deep thinking process about processing information in completing and solving complex problems. The dimensions of knowledge on HOTs include thinking processes at the levels of C4 (analysis), C5 (evaluation), and C6 (creating). The characteristics of HOTs-based questions are (1) measuring higher-order thinking skills, (2) using problems in everyday life, and (3) using various types of questions.

Student ability is very important to achieve student learning mastery. Moreover, in the development of the 4.0 century, students are expected to have the ability to think creatively and think at a higher level. It is hoped that there will be appropriate steps in making students able to improve their higher order thinking skills. There are many ways to do this. One of them is by developing students' mathematical literacy. According to(Melinda et al., 2014)there is a positive relationship between higher-order thinking and mathematical literacy, so to improve higher-order thinking skills is to improve students' mathematical literacy.

Mathematical literacy is one of the aspects measured in the studyProgram of International Student Assessment (PISA)(Astuti & Sabon, 2020). Mathematical literacy is very important for mathematics students in understanding and designing the problems they face to become future teachers. According to(Santoso & Setyaningsih, 2020)students with

high mathematical abilities are able to use the five basic mathematical literacy skills in solving HOTS questions in algebraic form. This means that with the existence of mathematical literacy, students and students are able to solve HOTS-based questions. With these basic mathematical literacy skills, students are expected to be able to design HOTS-based problems (High Order Thinking Skill).

Mathematical literacy is the ability to understand problems related to mathematics and can be applied in everyday life. According to(Kurniawati et al., 2020)Mathematical literacy can also be defined as students' mathematical ability to determine concepts, procedures, facts, and tools used in learning mathematics to explain, explain, and predict phenomena. Mathematical literacy is very useful to achieve higher order thinking skills of students. According to(Hutagaol & Sopia, 2020)mentions that in order to achieve higher-order thinking skills, learning must be accompanied by students' mathematical literacy skills. The jam according to(Amalia et al., 2022)that Literacy is the ability to read and write. Literacy as one indicator of achievement of development to the level of Elementary School (SD).

According to(Reny Kristyowati, 2019)scientific literacy is the ability, skill, competence possessed by students in using knowledge and understanding of scientific concepts and processes to identify, acquire new knowledge, explain scientific phenomena, and draw conclusions relating to nature based on natural changes through human activities.

According to(Melinda et al., 2014)there is a significant relationship between mathematical literacy and High Order Thinking ability, with the strength of the relationship between the two variables classified as moderate. This means that mathematical literacy and HOTs ability is a positive relationship meaning that the two variables have a unidirectional relationship, if students' mathematical literacy is high, the students' HOTs are also high, and vice versa. This shows that improving mathematical literacy or students' HOT abilities can be done by increasing one of these abilities. According to(Astuti & Sabon, 2020)that mathematics education students are at level 5 in solving HOTS questions using mathematical literacy skills. This shows that by using mathematical literacy students can solve HOTs questions that are at level 5. Based on research(Saragih & Nasution, 2019)that the preparation of HOTS-oriented questions or high-level thinking skills has been prepared based on appropriate operational verbs by taking into account the level of knowledge to the point of being able to analyze. Study(Hasnah et al., 2021)also explained that in compiling HOTS-based questions, training and mentoring were needed for teachers to improve their ability to compose HOTS questions. The percentage increase in the number of teachers who are able to design questions with the pre-rest and post-test HOTS criteria is 56.52%.

To prepare prospective teachers who are able to compete globally to face the current 4.0 curriculum century is to prepare students to be able to design or compile HOTS-based questions. Based on the description above, the researcher is interested in conducting research by findingthe effectiveness of mathematical literacy in HOTSbased student mathematics learning planning.

II. Review of Literature

This research is a qualitative descriptive study. Research that applies mathematical literacy in designing HOTs-based learning. This research was conducted in the department of mathematics education. The number of students is 43 students of the Mathematics Education Study Program, Faculty of Teacher Training and Education, University of Muhammadiyah North Sumatra for the 2020/2021 academic year. The object of this

research is learning planning based on HOTs. The instrument in this study was in the form of open-ended questions with two parts, namely preparing learning scenarios and designing HOTs questions using answer keys. Data analysis in this study is by analyzing the resultsstudent studyusing the average value, and analysis of the results of the documentation of student answers.

III. Result and Discussion

This research was carried out in 7 meetings, the material presented to students was in accordance with the semester learning plan. In these 7 meetings the researcher taught as usual. Learning is carried out after the mid-semester exam. Because the material related to mathematical literacy, lesson plans, and high other thinking is carried out after UTS. At the first meeting, the researcher stated the learning objectives.

The implementation of this research was carried out in accordance with the learning planned in the RPS for the study of curriculum planning and learning mathematics. Learning is carried out online using e-learning.

The following is a summary flow of several meetings based on the course RPS.

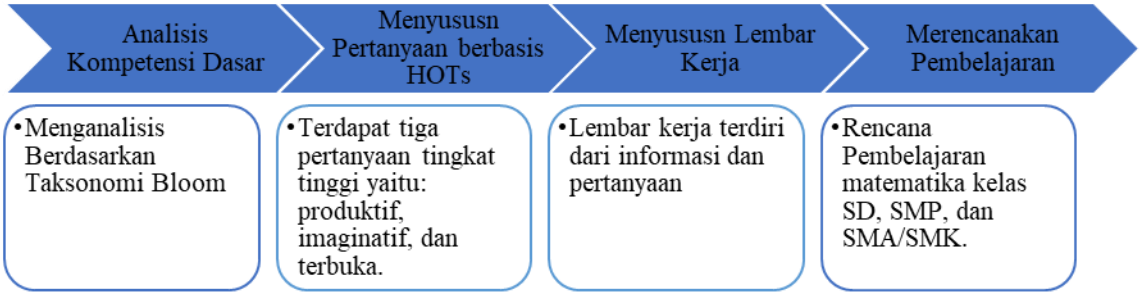


Figure 1. *Material Flow in HOTS-based Learning Planning*

At the initial meeting, students are first invited to analyze basic competencies. At this meeting, students analyze basic competencies by using operational verbs found in Bloom's Taxonomy. Among them are knowledge (C1), understanding (C2), application (C3),Analysis(C4),Evaluation (C5), andCreation (C6). Each level of Bloom's taxonomy has different operational verbs so that the basic competencies desired by the teacher are formed. The next meeting, students were invited to formulate HOTs-based questions consisting of productive questions, imaginative questions, and open-ended questions. In this course, students are maximized in discussing open-ended questions. Because these questions are more appropriate to use in learning mathematics.

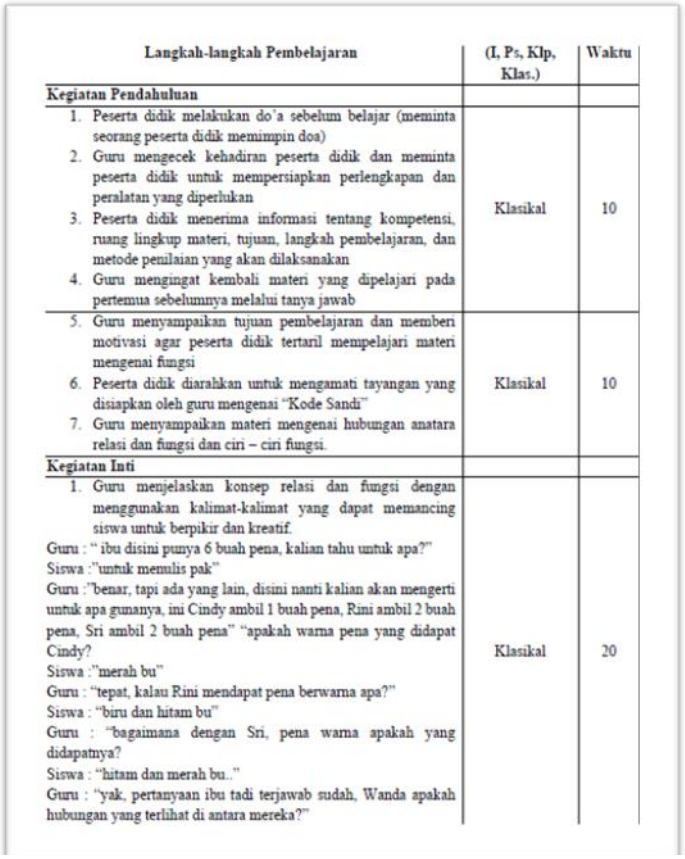
After students understand formulating basic competencies and formulating questions, students begin to compose worksheets that will be included in the lesson plan section later. The worksheet must meet the worksheet components and also be attractive. Then, in the last section, students are asked to prepare a lesson plan that contains learning activities that will be carried out in class. This lesson plan is structured into learning scenarios. In the learning scenario, it contains a whole series of learning activities in the classroom that are clearly described from the beginning of learning to the end of learning, using what learning methods/models, learning resources, and learning tools or teaching materials used.

Table 1. Completeness of HOTS that has been designed by students

No	tier	Scenario	LK	Source
1	SD Ex 1	Less complete No MIKiR penjelasan explanation	- Complete, there are information and orders - Questions/questions are not hot yet	3 Source bibliography
2	2nd grade junior high school	There are steps for the learning model Students are asked to present	- Complete, there is information and questions - There are HOTs	4 Source bibliography
3	3rd grade high school	There are no learning model steps	- Complete, there is information and questions - There are HOTs	Don't write down the source
4	SD Ex 4	There is exploration, elaboration, and confirmation	- Complete, there is information and questions - There are HOTs	1 source bibliography
5	SD Ex 7	There is exploration, elaboration, and confirmation	- Complete, there is information and questions - The questions are about HOTs	3 Source bibliography
6	JUNIOR HIGH SCHOOL Ex 8	Less complete There is no explanation on the main activity	- Complete, there is information and questions - The questions are about HOTs	Don't write down the source
7	JUNIOR HIGH SCHOOL Ex 5	There is exploration, elaboration, and confirmation	- Complete, there is information and questions - The questions are about HOTs	7 Source bibliography
8	6th grade high school	There are no learning model steps	- Incomplete, there are information and questions - There are no HOTs	Don't write down the source
9	9th grade junior high school	There are steps for the learning model Students are asked to present	- Complete, there is information and questions - There are no HOTs	4 Source bibliography

Of the 9 groups that completed and compiled HOTs questions, there were 7 groups who were able to develop lesson plans by applying mathematics in everyday life and compiling open-ended questions. This means that as many as 78% of students are able to develop a mathematics lesson plan by applying mathematics in everyday life (literacy). So that by using mathematical literacy, students are able to design lesson plans based on HOTs questions.

The following are learning scenarios and worksheets containing HOTs-based questions.

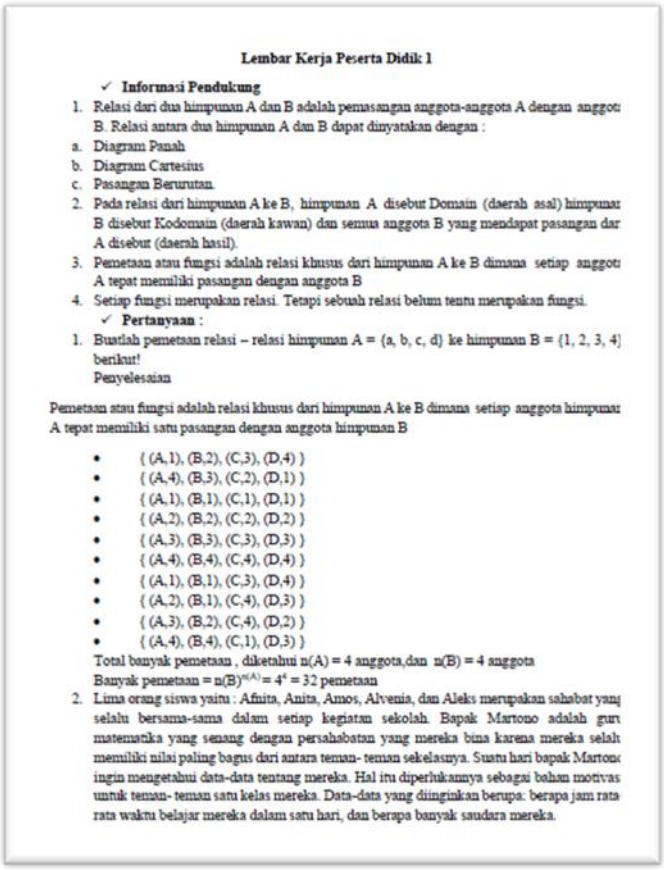


Langkah-langkah Pembelajaran	(I, Ps, Klp, Klas.)	Waktu
Kegiatan Pendahuluan		
1. Peserta didik melakukan do'a sebelum belajar (meminta seorang peserta didik memimpin doa) 2. Guru mengecek kehadiran peserta didik dan meminta peserta didik untuk mempersiapkan perlengkapan dan peralatan yang diperlukan 3. Peserta didik menerima informasi tentang kompetensi, ruang lingkup materi, tujuan, langkah pembelajaran, dan metode penilaian yang akan dilaksanakan 4. Guru mengingat kembali materi yang dipelajari pada pertemua sebelumnya melalui tanya jawab	Klasikal	10
5. Guru menyampaikan tujuan pembelajaran dan memberi motivasi agar peserta didik tertaril mempelajari materi mengenai fungsi 6. Peserta didik diarahkan untuk mengamati tayangan yang disiapkan oleh guru mengenai "Kode Sandi" 7. Guru menyampaikan materi mengenai hubungan anatara relasi dan fungsi dan ciri – ciri fungsi.	Klasikal	10
Kegiatan Inti		
1. Guru menjelaskan konsep relasi dan fungsi dengan menggunakan kalimat-kalimat yang dapat memancing siswa untuk berpikir dan kreatif. Guru : " ibu disini punya 6 buah pena, kalian tahu untuk apa?" Siswa :"untuk menulis pak" Guru :"benar, tapi ada yang lain, disini nanti kalian akan mengerti untuk apa gunanya, ini Cindy ambil 1 buah pena, Rini ambil 2 buah pena, Sri ambil 2 buah pena" "apakah warna pena yang didapat Cindy? Siswa :"merah bu" Guru : "tepat, kalau Rini mendapat pena berwarna apa?" Siswa : "biru dan hitam bu" Guru : "bagaimana dengan Sri, pena warna apakah yang didapatnya? Siswa : "hitam dan merah bu.." Guru : "yak, pertanyaan ibu tadi terjawab sudah, Wanda apakah hubungan yang terlihat di antara mereka?"	Klasikal	20

Figure 2. *Scenario or Math Lesson Plan*

Figure 2. is an example of a lesson plan that has been designed by student teacher candidates which shows that in the lesson plan students use real teaching materials, namely in the form of writing instruments "pen" to understand the learning material relations. a teacher also explains to students about relationships or relationships through objects in everyday life.

This is also not much different for the worksheets which are a supporting part in the preparation of HoTs-based learning plans. The following is an example of a student-designed worksheet.



Lembar Kerja Peserta Didik 1

✓ **Informasi Pendukung**

1. Relasi dari dua himpunan A dan B adalah pemasangan anggota-anggota A dengan anggot B. Relasi antara dua himpunan A dan B dapat dinyatakan dengan :

a. Diagram Panah
b. Diagram Cartesius
c. Pasangan Berurutan.

2. Pada relasi dari himpunan A ke B, himpunan A disebut Domain (daerah asal) himpuna B disebut Kodomain (daerah kawan) dan semua anggota B yang mendapat pasangan dar A disebut (daerah hasil).
3. Pemetaan atau fungsi adalah relasi khusus dari himpunan A ke B dimana setiap anggot A tepat memiliki pasangan dengan anggota B
4. Setiap fungsi merupakan relasi. Tetapi sebuah relasi belum tentu merupakan fungsi.

✓ **Pertanyaan :**

1. Buatlah pemetaan relasi – relasi himpunan A = {a, b, c, d} ke himpunan B = {1, 2, 3, 4} berikut!
   Penyelesaian

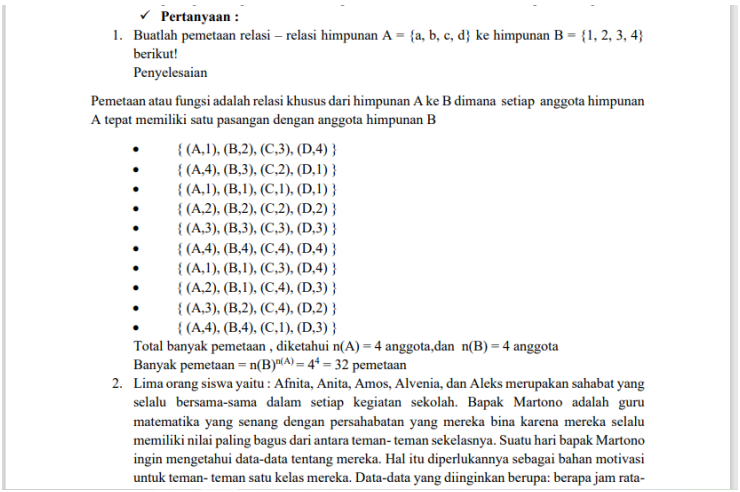
Pemetaan atau fungsi adalah relasi khusus dari himpunan A ke B dimana setiap anggota himpuna A tepat memiliki satu pasangan dengan anggota himpunan B

- { (A,1), (B,2), (C,3), (D,4) }
- { (A,4), (B,3), (C,2), (D,1) }
- { (A,1), (B,1), (C,1), (D,1) }
- { (A,2), (B,2), (C,2), (D,2) }
- { (A,3), (B,3), (C,3), (D,3) }
- { (A,4), (B,4), (C,4), (D,4) }
- { (A,1), (B,1), (C,3), (D,4) }
- { (A,2), (B,1), (C,4), (D,3) }
- { (A,3), (B,2), (C,4), (D,2) }
- { (A,4), (B,4), (C,1), (D,3) }

Total banyak pemetaan , diketahui n(A) = 4 anggota,dan n(B) = 4 anggota
Banyak pemetaan = $n(B)^{n(A)} = 4^4 = 32$ pemetaan

2. Lima orang siswa yaitu : Afnita, Anita, Amos, Alvenia, dan Aleks merupakan sahabat yan selalu bersama-sama dalam setiap kegiatan sekolah. Bapak Martono adalah gur matematika yang senang dengan persahabatan yang mereka bina karena mereka selal memiliki nilai paling bagus dari antara teman- teman sekelasnya. Suatu hari bapak Martono ingin mengetahui data-data tentang mereka. Hal itu diperlukannya sebagai bahan motivas untuk teman- teman satu kelas mereka. Data-data yang diinginkan berupa: berapa jam rata rata waktu belajar mereka dalam satu hari, dan berapa banyak saudara mereka.

Figure 3. *HOTs Questions in Student Worksheets*



✓ **Pertanyaan :**

1. Buatlah pemetaan relasi – relasi himpunan A = {a, b, c, d} ke himpunan B = {1, 2, 3, 4} berikut!
   Penyelesaian

Pemetaan atau fungsi adalah relasi khusus dari himpunan A ke B dimana setiap anggota himpunan A tepat memiliki satu pasangan dengan anggota himpunan B

- { (A,1), (B,2), (C,3), (D,4) }
- { (A,4), (B,3), (C,2), (D,1) }
- { (A,1), (B,1), (C,1), (D,1) }
- { (A,2), (B,2), (C,2), (D,2) }
- { (A,3), (B,3), (C,3), (D,3) }
- { (A,4), (B,4), (C,4), (D,4) }
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Total banyak pemetaan , diketahui n(A) = 4 anggota,dan n(B) = 4 anggota
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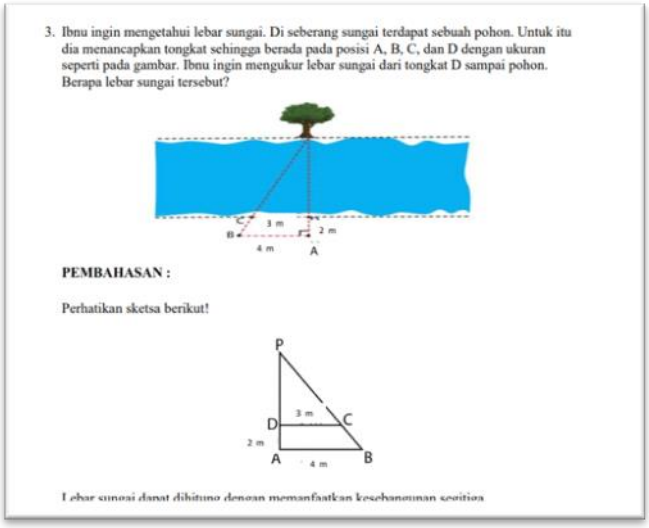
Figure 3. *HOTs Questions in Student Worksheets*


3. Ibnu ingin mengetahui lebar sungai. Di seberang sungai terdapat sebuah pohon. Untuk itu dia menancapkan tongkat sehingga berada pada posisi A, B, C, dan D dengan ukuran seperti pada gambar. Ibnu ingin mengukur lebar sungai dari tongkat D sampai pohon. Berapa lebar sungai tersebut?

PEMBAHASAN :

Perhatikan sketsa berikut!

Lebar sungai dapat dihitung dengan memanfaatkan kesebangunan segitiga

Figure 5. *HOTs Questions in Student Worksheets*

Based on Figure 5.3 we can see that students are able to design HOTs-based worksheets. Where each question on the worksheet has more than one correct answer. So that each student will answer questions with different answers according to their abilities. In addition, students have been able to apply mathematics in everyday life.

3.1 Research Discussion

Based on Figures 5.3, 5.4, and 5.5 that student teacher candidates have been able to compile HOTs questions by applying mathematics in everyday life. This is in accordance with research(Dini, 2018)that there is a significant relationship between mathematical literacy and High Order Thinking ability, with the strength of the relationship between the two variables classified as moderate. The study explains that mathematical literacy skills and high order thinking skills are not only limited to numeracy skills, but also how to apply mathematics in everyday life to solve a problem, how to communicate it, thus it can be seen how the mathematical thinking process of students is. According to(Melinda et al., 2014)there is a significant relationship between mathematical literacy with the ability of students' High Order Thinking Skill. The relationship between mathematical literacy and HOT ability is a positive value relationship, meaning that the two variables have a unidirectional relationship, if students' mathematical literacy is high, the students' HOT abilities are also high, and vice versa.

From the results of the study there were as many as 78% of student groups who were able to develop lesson plans by applying mathematics in everyday life. This means that students have been able to compile this in line with research(Hutagaol & Sopia, 2020)that as many as 71.15% of students' mathematical literacy skills are effective when solving HOTs-based questions. According to(Mushlihuddin et al., 2021)that in the preparation of HOTS-oriented lesson plans there are several steps including understanding the concept of HOTS learning, analyzing KD, determining KD targets, determining learning activities that include ABCD (Audience, Behavior, Condition, Degree). This process cannot be separated from good literacy, so this activity is very useful in preparing HOTS questions in the 2013 curriculum.

According to (Rohim, 2019)strategies for preparing HOTs questions are (1) analyzing the basic competencies that will be made about HOTs, (2) compiling a grid of questions, (3) using interesting problems in everyday life, (4) writing questions, and (5) make assessment guidelines and answer keys. Besides that, according to(Kurniawati et al.,

2020)that in order to increase students' mathematical literacy, teachers should provide motivation and assignments in the form of HOTS-based questions. According to(Hasnah et al., 2021)that Based on the results of group work carried out by the participants, their ability to design and analyze HOTS-based questions increased, both at the C4, C5, and C6 levels.

IV. Conclusion

This research resulted in effective mathematical literacy used in planning mathematics learning based on HOts. Students who use more mathematical literacy will be able to plan HOTs-based mathematics learning better. The average value of students in planning HOTs-based mathematics learning is 85.7%. And the HOTs-based learning planning that has been designed by students, 77.8% of students have been able to design questions and their answers by applying questions in everyday life and designing open-ended questions.

Suggestions to further researchers for the application of HOTS in the design of mathematics learning plans so that an assessment is carried out for each individual in order to obtain maximum results and can be truly understood by each student.

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