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Jurnal Riset Pendidikan Matematika 9 (2), 2022, 115-123

The ability of Junior High School mathematics teachers writing *Higher Order Thinking Skills* (HOTS) questions

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ARTICLE INFO

Article history :
Received: 5 Des 2022
Revised: 3 April 2023
Accepted: 3 April 2023

Keywords :
HOTS, junior high school mathematics, teacher's competence

Scan me:

ABSTRACT

This study is a survey research with a cross-sectional survey design, which aims to describe the ability of junior high school mathematics teachers to write HOTS items. The population of this study was junior high school mathematics teachers in Sleman Regency, while the sample was 21 teachers determined by non-stratified random sampling. The sample teachers came from 11 schools totaling 21 teachers. Each teacher created three HOTS items along with their grids. The question items made by the sample teachers were descriptive questions. Two mathematics teachers from leading junior high schools in Yogyakarta reviewed the question items that had been prepared. The next stage after validation is the trial. The number of respondents used was 263 for testing teacher-made questions, namely 127 students in class VIII and 136 in class VII. The results showed that the quality of the questions produced by the teacher based on the reliability estimation results obtained an estimate of 0.635 for class VII and 0.416 for class VIII. Likewise, the resulting differentiating power is less than 50% of the questions made by teachers with differentiating power in the sound, reasonable and excellent categories. Factors that cause this include teachers' lack of experience writing HOTS questions. This is a special note to familiarize teachers with using HOTS questions in daily tests, UTS, and UAS proportionally so that the experience and ability of teachers to write HOTS questions increases.

How to Cite: Hamdi, S., Kartowagiran, B., Istiyono, E., Rahman, H.N., 2022, The ability of Junior High School mathematics teachers writing Higher Order Thinking Skills (HOTS) questions, *Jurnal Riset Pendidikan Matematika,* 9 (2), 115-123, https://doi.org/10.21831/jrpm.v9i2.55191

INTRODUCTION

Education has an essential role in improving the quality of people's lives. In order to promote good quality education following the demands of society in this global era, good quality human resources are needed. Good quality human resources are knowledgeable, skilled, virtuous, noble character, responsible, and have a solid will to seek their well-being and contribute to the harmony and prosperity of the family, community, and country (BSNP, 2006). Quality human resources can be obtained from a good quality education.

The National Examination (UN) is one of the government's efforts to spur quality improvement or the quality of education. While functioning to measure and assess the achievement of graduate competencies in certain subjects and mapping the quality of education at the primary and secondary education levels, The National Examination also motivates related parties to work better to achieve good exam results. The assessment system and the quality of learning are two interrelated things. A sound learning system will produce good-quality learning (Djemari Mardapi, 2012). Furthermore, the quality of learning could be seen from the assessment results carried out by the teacher or educator. Teachers are professional educators with the main task of educating, teaching,

guiding, directing, training, assessing, and evaluating students in early childhood education through formal education, primary education, and secondary education (Law, 2005).

Based on Law no. 14 of 2005 concerning Teachers and Lecturers, it is clear that the role of educators is not only to design and promote learning but also to carry out assessments. Assessment of student learning outcomes should be carried out continuously. Assessment is intended to determine whether or not the set goals have been achieved, whether these goals are important for the students, and how they are achieved. The study results show that 87 percent of teachers still have difficulty understanding how to carry out assessments (Rohmawati, 2013). Unpopular steps in conducting an assessment are one of the obstacles. This indicates that the teacher's ability to conduct a reasonable assessment still needs to be improved.

A good assessment can be conducted by collecting objective evidence regarding the student's achievement, and the results are beneficial for students to increase their motivation and learning achievement (Stiggins & Chappuis, 2012). Thus, the assessment of learning outcomes must be able to assess student learning progress. Information on student learning progress can be used as a consideration for making a decision about the status of students in their group and determining the next steps. Therefore, in assessing learning outcomes, it is necessary to design the steps in detail to describe the student competencies accurately.

In the industrial revolution 4.0, teachers are more required to promote learning and assessments based on high-level reasoning skills (Higher Order Thinking Skills = HOTS). Thomas & Thorne (2014) state that high-level reasoning/HOTS is the ability to think higher than just remembering facts or retelling something heard/known to others. Thomas & Thorne explained that high-level reasoning abilities require a person to perceive the facts obtained by understanding, concluding, associating them with other facts in new ways, and applying them to find solutions to a problem. High-level reasoning abilities can also occur when students acquire new knowledge and store it in their memory, then connect it with the previous knowledge to achieve specific goals (Abosalem, 2016). In this case, the teacher's role is crucial in implementing critical thinking/HOTS reasoning skills on math problems. The teacher's ability to develop HOTS-based questions is still relatively low and is still dominated by lower-order thinking skills elements (Iskandar & Senam, 2015). therefore, the information regarding a description of the teacher's ability to make HOTS questions at this time is needed, so the purpose of this study was to describe the ability of junior high school mathematics teachers to write HOTS items.

METHOD

This study aims to describe the ability of junior high school mathematics teachers to write HOTS questions. To describe the teacher's ability, the first stage was conducting an initial survey related to the prior knowledge of junior high school teachers in the Sleman district related to HOTS questions and the steps in their arrangement. The next step was asking teachers to make HOTS math questions. The population of this study was junior high school mathematics teachers in Sleman Regency. This research was survey research with a cross-sectional survey design.

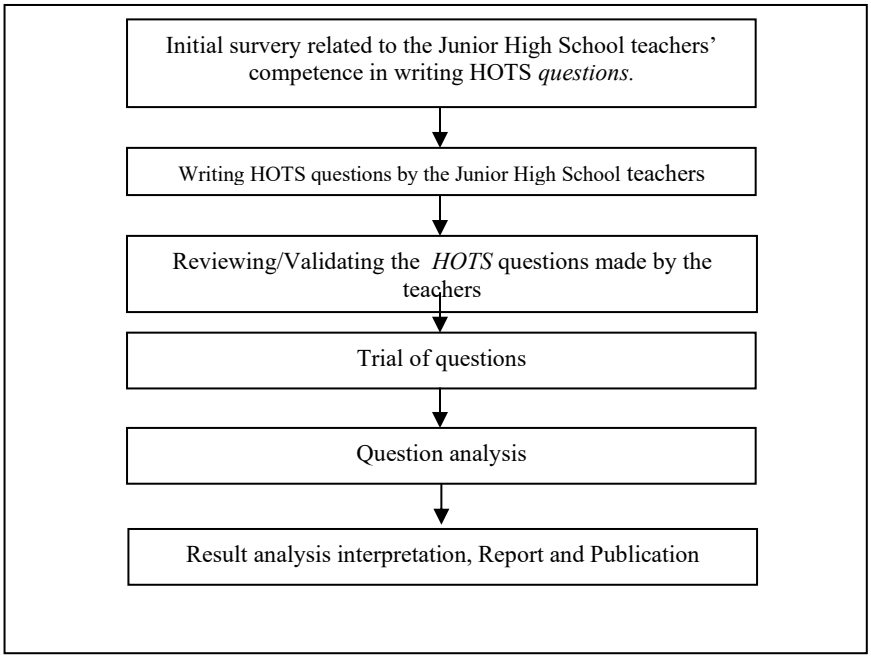

Figure 1. Research procedure

The population of this study was junior high school mathematics teachers in Sleman Regency, while the sample consisted of 21 teachers who were determined by non-stratified random sampling. Sample teachers came

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

from 11 schools, with 21 teachers in total. Each teacher makes three HOTS questions along with the grid. The items made by the sample teacher were descriptive questions. This study also involved 263 students trying out teacher-made questions, namely 127 students in class VIII and 136 in class VII. Two mathematics teachers from the leading junior high school in Yogyakarta reviewed the completed questions. The next stage after the validation process is the trial stage. The test results were analyzed quantitatively using a classical approach.

The data collection method was collected using test techniques, questionnaires, and expert judgment using assessment sheets—the HOTS math questions for junior high school were produced and tested for further analysis. The questionnaire was used to determine the teacher's initial knowledge of HOTS questions. Score sheets were prepared to assess the quality of the instrument by experts. The testing results on students were analyzed to see the quality of the teacher's HOTS Mathematics Senior High School questions. Data in the form of student responses were analyzed using classical test theory. Analysis using the classical test approach was to find the level of difficulty and item discriminatory power. In addition to the classical test theory approach, the test results were then examined regarding their validity and reliability index. The validity obtained was measured using Aiken by looking at the content-validity coefficient, which is based on the assessment results from a panel of experts, to what extent the item represents the intended construct. The reliability index is calculated using the classical test theory approach with the Alpha formula. The results of the analysis were used as the basis for describing the ability of junior high school mathematics teachers to create HOTS questions, which were strengthened by the analysis of teacher response questionnaires and expert assessments.

Result and Discussion

Teacher's experience related to the assessment and the ability of junior high school mathematics teachers in writing HOTS questions

Understanding the teacher's experience before the research process is essential, at least with simple questions, starting from the teacher's understanding of HOTS questions to the experience of making HOTS grids and instruments. A deep exploration of teachers' needs to ensure that the follow-up provided will be reliable, such as training teachers in making the test grids and items. The data based on a simple questionnaire related to the teacher's experience in arranging HOTS questions and assessments are summarized in Figure 2.

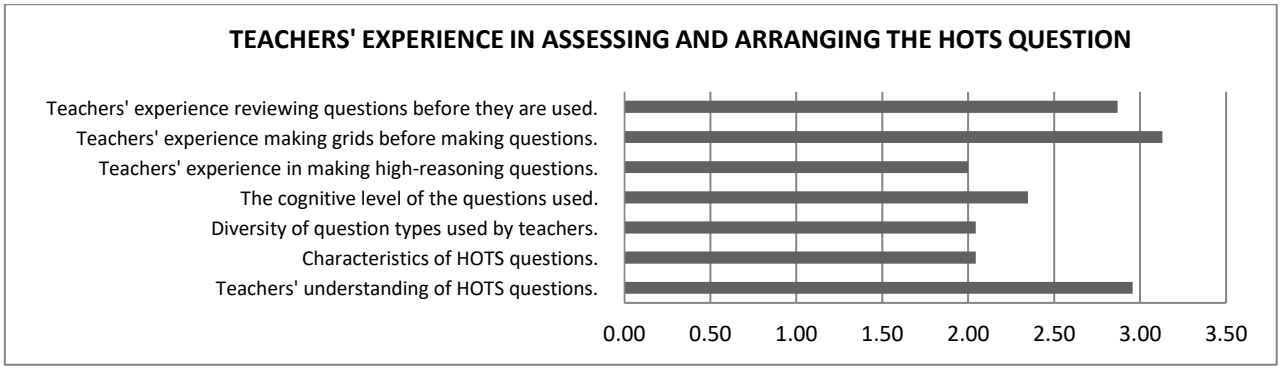

Figure 2. Teachers' experience in assessing and arranging the HOTS Question

Based on Figure 2, information can be obtained if: the teacher's experience is 2.80 in the excellent category, the teacher's experience in making grids is 3.20 in the good category, the teacher's experience in making questions is 2.00 in the wrong category, the cognitive level of the questions used is 2.30 in the pretty good category; the diversity of the types of questions used is 2.10 in the poor category; the teacher's ability to mention and explain the characteristics of HOTS questions is 2.10 which is in the poor category, and the teacher's understanding of HOTS questions is 2.90 which is in the excellent category.

The data shown by the numbers above basically indicate a problem with the teacher's understanding of HOTS questions. This can be proven by an imbalance between teacher statements regarding their understanding of HOTS questions where the average answer was "understand" but had not yet reached the implementation stage. This condition was supported by the imbalance of several indicators arranged into questions on the instrument used, where the teacher's statement about their understanding of making HOTS question grids and statements about study habits were not directly proportional to the type and level of questions used in assessing people experiencing poverty and pretty good category. So, it can be concluded that the average teacher was still in the "adequate" category from a theoretical and practical point of view. In making HOTS questions, training or other similar activities must be carried out so that the teacher's understanding and experience are more comprehensive and maximal.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Validity and Reliability of HOTS Question produced by the Senior High School Teachers

All Basic Competency (KD) and Indicators that mathematics teachers have made are then assessed with a quantitative assessment process by two qualified colleagues who often attend training and become national instructors for the 2013 curriculum, namely Mathematics Teachers at SMPN 8 Yogyakarta and SMPN 5 Yogyakarta. The value given by the assessors was based on consideration of the relevance of the Indicators to KD presented in Figure 3.

Five criteria were used in this quantitative assessment, one (1) score if the indicator was not essential or irrelevant, and two (2) if it was helpful but not essential/less relevant. At the same time, three (3) if the item was quite essential/relevant enough, four (4) if the item was essential or relevant, and five (5) if the item was essential or very relevant. The analysis used Aiken's V formula to obtain the item validity index.

Content Validity Aiken's V

KD Number	Indicator Number	n = 2		s = r - lo		$\sum s$	V
		Expert 1	Expert 2	S1	S2		
3.2	Indicator 3.2.1	4	5	3	4	7	**0.88**
	Indicator 3.2.2	4	5	3	4	7	**0.88**
	Indicator 3.2.3	4	5	3	4	7	**0.88**
3.3	Indicator 3.3.1	4	5	3	4	7	**0.88**
	Indicator 3.3.2	2	5	1	4	5	**0.63**
	Indicator 3.3.3	4	5	3	4	7	**0.88**
3.4	Indicator 3.4.1	4	4	3	3	6	**0.75**
	Indicator 3.4.2	5	2	4	1	5	**0.63**
	Indicator 3.4.3	4	2	3	1	4	**0.50**
	Indicator 3.4.4	5	5	4	4	8	**1.00**
	Indicator 3.4.5	5	5	4	4	8	**1.00**
	Indicator 3.4.6	5	5	4	4	8	**1.00**
3.5	Indicator 3.5.1	5	5	4	4	8	**1.00**
	Indicator 3.5.2	4	5	3	4	7	**0.88**
	Indicator 3.5.3	5	5	4	4	8	**1.00**
Content Validity Index							**0.85**

Figure 3. The relevance of indicator towards VII class of Senior High School

Content Validity Aiken's V

Indicator Number	Question Item Number	n = 2		s = r - lo		$\sum s$	V
		Expert 1	Expert 2	S1	S2		
Indicator 3.2.1	Question_1	4	5	3	4	7	**0.88**
Indicator 3.2.2	Question_2	4	3	3	2	5	**0.63**
Indicator 3.2.3	Question_3	5	5	4	4	8	**1.00**
Indicator 3.3.1	Question_4	4	4	3	3	6	**0.75**
Indicator 3.3.2	Question_5	2	5	1	4	5	**0.63**
Indicator 3.3.3	Question_6	4	5	3	4	7	**0.88**
Indicator 3.4.1	Question_7	4	4	3	3	6	**0.75**
Indicator 3.4.2	Question_8	4	4	3	3	6	**0.75**
Indicator 3.4.3	Question_9	4	5	3	4	7	**0.88**
Indicator 3.4.4	Question_10	5	5	4	4	8	**1.00**
Indicator 3.4.5	Question_11	4	5	3	4	7	**0.88**
Indicator 3.4.6	Question_12	4	5	3	4	7	**0.88**
Indicator 3.5.1	Question_13	5	5	4	4	8	**1.00**
Indicator 3.5.2	Question_14	4	5	3	4	7	**0.88**
Indicator 3.5.3	Question_15	5	5	4	4	8	**1.00**
Content Validity Index							**0.85**

Figure 4. The relevance of items with the indicator for grade VII of Senior High School

Figure 3 shows that the validity index of each indicator was above the minimum criteria and categorized as valid except for indicator 3.4.3, which gained the lowest rating, namely 0.5. However, in general, the content validity has met 0.85, indicating that the instrument grid was valid.

After measuring the suitability of the indicators for KD, they were then measuring the suitability of the items for class VII SMP indicators. The results using Aiken's formula are described in Figure 4. Figure 4 shows

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

that the validity index of each item was above the minimum criteria, and the content validity index obtained was 0.85, indicating that the instrument items were valid.

All KD and class VIII indicators produced were also asked for a quantitative assessment of two colleagues who often attended training and became national instructors for the 2013 curriculum, namely Mathematics Teachers at SMPN 8 Yogyakarta and SMPN 5 Yogyakarta. The assessors' value was based on considering the relevance of the Indicators to KD for class VIII.

Data analysis results show that the validity index of each indicator was above the minimum criteria and categorized as valid except for indicators 3.1.3, 3.2.2, and 3.3.3. who received the lowest rating, namely below 0.5. However, in general, the content validity has met 0.80, indicating that the instrument grid was valid. Then the validity index for each item was not all in the valid category because it was under the minimum criteria, namely 41, 30, 26, 25, and 14 got a result of 0.25, and items 40, 34, 27, and 18 got a result of 0.50. According to Aiken, the content validity was generally fulfilled, namely 0.73, which indicated that the instrument was valid. As for the reliability of class VII and Class VIII instruments, each got an estimated value of 0.635 for class VII and 0.416 for class VIII. According to Nunnally (1978), a sound/high-reliability index is 0.60 - 0.70, the average reliability index is 0.40 - 0.60, and for objective tests, the reliability index is 0.75-0.90. So that the reliability of the instrument obtained was concluded that entering class VII obtained good/high reliability while class VIII received moderate reliability.

The quality of Junior High School HOTS questions based on the difficulty level and different power

The quality of questions is viewed based on the difficulty level, and the different power of the questions made by the mathematics teacher for grades VII and VIII of junior high school is presented in table 1.

Table 1. The difficulty level for the VII and VIII class

No	Items	Difficulty level	Description
Class VII			
1	Item_1	0.44	Medium
2	Item_2	0.56	Medium
3	Item_3	0.11	Diffucult
4	Item_4	0.19	Difficult
5	Item_5	0.20	Diffucult
6	Item_6	0.12	Difficult
7	Item_7	0.21	Diffucult
8	Item_8	0.25	Difficult
9	Item_9	0.24	Diffucult
10	Item_10	0.09	Difficult
11	Item_11	0.05	Diffucult
12	Item_12	0.09	Difficult
13	Item_13	0.07	Diffucult
14	Item_14	0.04	Difficult
15	Item_15	0.02	Diffucult
Class VIII			
1	Butir_1	0.56	Medium
2	Butir_2	0.46	Medium
3	Butir_3	0.11	Difficult
4	Butir_4	0.25	Diffucult
5	Butir_5	0.11	Difficult
6	Butir_6	0.22	Diffucult
7	Butir_7	0.25	Difficult
8	Butir_8	0.15	Diffucult
9	Butir_9	0.05	Difficult
10	Butir_10	0.03	Diffucult
11	Butir_11	0.03	Difficult
12	Butir_12	0.07	Diffucult
13	Butir_13	0.10	Difficult
14	Butir_14	0.33	Medium
15	Butir_15	0.06	Difficult

Based on Table 1, only two math questions for class VII were in the medium category, and three math questions for class VIII were in the medium category. In addition, the questions made by the teacher were in the

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difficult category. The difficult category for HOTS questions could be accepted if the discriminating power, validity, and reliability meet. Different power questions will be shown in Table 2.

Table 2. Different Power of Question for VII and VIII Class

No	Items	Different Power	Description
Kelas VII			
1	Item_1	0.15	Bad
2	Item_2	0.24	Quite good
3	Item_3	0.07	Bad
4	Item_4	0.22	Quite good
5	Item_5	0.16	Bad
6	Item_6	0.21	Quite good
7	Item_7	0.28	Quite good
8	Item_8	0.32	Good
9	Item_9	0.25	Quite good
10	Item_10	0.28	Quite good
11	Item_11	0.14	Bad
12	Item_12	0.12	Bad
13	Item_13	0.11	Bad
14	Item_14	0.05	Bad
15	Item_15	0.07	Bad
Class VIII			
1	Item_1	0.12	Bad
2	Item_2	0.06	Bad
3	Item_3	0.01	Bad
4	Item_4	0.18	Bad
5	Item_5	0.18	Bad
6	Item_6	0.09	Bad
7	Item_7	0.30	Good
8	Item_8	0.21	Quite good
9	Item_9	0.14	Bad
10	Item_10	0.04	Bad
11	Item_11	0.15	Bad
12	Item_12	0.14	Bad
13	Item_13	0.05	Bad
14	Item_14	0.50	Very good
15	Item_15	0.23	Quite good

Based on Table 2 above, it can be described that math questions for class VII, items 1, 3, 5, 11, 12, 13, 14, and 15 have discriminating power, which is in the bad category, and items 2, 4, 6, 7, 9 and 10 were in the pretty good category and item 8 is in a good category. The difference was the questions made by the teacher for class VIII, all of which were in the bad category except for items 7, 8, 14, and 15, which were quite good, good, and very good, respectively, namely item 14.

The most dominant problem of Junior High School teachers is arranging the Mathematic HOTS question.

The most dominant problem for junior high school teachers in preparing HOTS Mathematics questions based on the results of interviews with teachers was trying to start and get used to giving questions by compiling questions that fall within the HOTS criteria. Understanding HOTS criteria or characteristics and forming them into indicators and items were also problematic for some teachers. Of the 21 teachers interviewed, 11 teachers stated that they understood HOTS, and after being asked to mention the bloom taxonomy criteria, which included HOTS, 11 teachers answered C2 and C3. This became one of particular concern. Examples of indicators made by the teacher are shown in Figure 5.

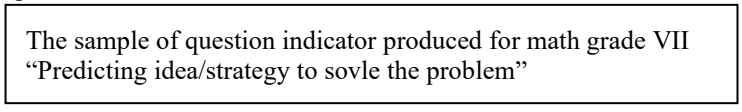

Figure 5. The sample of question indicators produced by the teachers

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

These indicators are too general, and solving a problem is not explicitly stated. Referring to the questions, the indicator should be "Students can determine the product of exponents with different base numbers." Questions from the indicators mentioned above are as follows.

Predict ideas/strategies to solve a problem. Students can determine the product of multiplication with different base numbers.	4	Find the result of : $(4^3 \times 2^4)^2$

Figure 6. Mathematic question for VII grade made by the teachers

The teacher's results were still at the C1-C3 level, so they are part of the HOTS questions. It can be seen that these questions require conceptual understanding and do not use higher-order thinking skills such as reasoning, analysis, evaluation, or creation. According to Siti Nursaila Alias & Faridah Ibrahim (2015) the ability to think at a high level is an ability possessed by someone to apply knowledge, skills, and values in making reasoning and reflection to solve problems, make decisions, innovate, and the ability to create something. This opinion clearly shows that higher-order thinking is not limited to understanding concepts. Most teachers show a lot of uncertainty and disbelief in the HOTS concept and feel unprepared to teach or assess using HOTS questions (Schulz & FitzPatrick, 2016), teachers' knowledge of HOTS, their ability to improve student HOTS, solve HOTS-based problems, and measure activities Student HOTS was still low (Retnawati et al, 2018). So the teacher must understand the essence and primary purpose of Higher Order Thinking Skills (HOTS) to increase the level of student thinking, significantly improve critical thinking skills in processing various types of information, creativity in solving complex problems using the knowledge they have and make decisions in complex situations as well (Astuti, 2018).

The following is an example question made by the teacher for grade VIII.

You are given 2 function formulas. Students can determine if a function maps to another function.	25	If $f(x) = 3x-4$ $g(x) = x2+3$ then $f(g(x))$ is...
Given a function formula. Students are able to determine the relationship of the value of f(x) to the value of x.	26	Let $f(x) = 4-3x$ If $f(a) = 10$ then the value is....
You are given function notation. Students are able to determine the relationship of the value of f(x) to the value of x.	27	The function $g : x \rightarrow ax2 - 4$. What is the value of $g(3) + g(-2)$

Figure 7. The teachers made the mathematics question for the VIII class.

Figure 7. explains that the questions made by the teacher have not yet been entered at level 4-6, so it cannot be said that it is HOTS questions. Based on the results of the interviews with the teacher where the trial was held regarding the question, it was classified as HOTS because not many students could answer the question correctly. This became a concern because difficult questions, according to students, are not necessarily HOTS. After all, according to students in certain schools, difficulties may be easy for students in other schools. Because the accuracy of the questions as presented in each material chapter must follow the material, the level of difficulty varies according to the space that supports it. In order to achieve basic competence, all questions presented must be realistic and robust; there are practice questions that require students to think at a high level (Pramesti, 2017). Several aspects show higher-order thinking skills (HOTS), critical thinking skills, creativity, and problem-solving independently as an indicator of higher-order thinking skills or HOTS (Higher Order Thinking Skills). These three aspects are indicators of HOTS (Higher Order Thinking Skill) type questions used to measure students' ability to think at a higher level (Setiawati, 2019). So, HOTS is not just the ability to remember but requires complex thinking and solving complex problems that require creative thinking and critical analysis to find solutions (Anggraini, 2019).

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

In addition, questions that are commonly used daily still use comprehension level questions, namely between C1-C3, and only 3 out of 21 teachers stated that they had used HOTS questions several times in their daily tests or UTS. Examples of indicators and questions the teacher makes are as follows.

Examples of Teacher-Made Indicators
Creating a mathematical model and determining the solution to a system of two-variable linear equations using the elimination and substitution methods.

Figure 8. Example of Teachers-made Indicators

On Sundays Dina and Tika went to the shop to buy ties and hats after looking at the price of hats for elementary school students, junior high school students and high school students the same as the price of the tie. The price list shows the following prices. The price of 1 hat = the price of 2 ties, the price of 1 hat and 1 tie is Rp. 22,500. If Dina and Tika are going to buy 8 ties and 6 hats, the money they will pay is ....

Figure 9. Example of teachers-made question

The teacher's results have been good in making HOTS indicators and questions. These questions require a high level of reasoning to create a mathematical model and determine the solution. In addition, the context used is quite close to the student context. This is a motivation in itself. The research by Wanty Widjaja (2013) proves that realistic problems in learning mathematics can help students interpret contexts, explore ideas, and build relationships between contexts and ideas to support the development of mathematical abilities. Then, Siti Mufidah (2017) also explained that learning activities using a realistic mathematical approach to problem-solving according to context could trigger students to develop higher-order thinking skills. Higher-order thinking skills can be developed through problem-solving habits that involve analyzing, evaluating, and creating. Students are encouraged to solve conceptual problems given through non-routine questions with the knowledge they already have. Student's ability to analyze trains students to think critically with logical reasons, solve complex problems with arguments, and understand practical mathematical problems through analysis. By analyzing, students can think critically, which triggers effort.

The results obtained by the students where the trials held were still far from expectations; this was due to several factors, including the habituation of students being tested with HOTS questions; besides that, the questions used by the teacher did not use real questions. A study by Ibrahim Bayazit (2013) shows that students tend to ignore critical thinking models that should be used in solving problems if the questions and list of questions are not connected with routine information, procedures, and other factual information. These conditions indicate that the use of realistic problems in preparing training instruments or tests and lists of questions helps students think critically and look for alternative answers. A problem is classified as realistic if the problem can be imagined in students' minds and is not always a problem that exists in real life (Ariyadi W., 2012).

CONCLUSION

Based on the results of the analysis and review of the teacher's work, it can be concluded that the quality of the questions produced by the teacher based on the reliability estimate obtained an estimate of 0.635 for class VII and 0.416 for class VIII. Likewise, with the discriminating power produced, less than 50% of the questions made by teachers with discriminating power are in the category of reasonably good, sound, and very good. The results that have been obtained from the teacher have been good in making HOTS indicators and questions. This problem requires a high level of reasoning to create a mathematical model and determine the solution. For the average difficulty level, it is in the difficult category. Students can continue to be given HOTS questions to get used to working on the questions. This is a special note to accustom teachers to using HOTS questions in daily assessments, PTS, and PAS proportionally, and special training should be given in stages and continuously for junior high school mathematics teachers in the Sleman Region in the future.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

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ISSN 2356-2684 (print), ISSN 2477-1503 (online)