Development And Validation Instrument To Measure Teacher Knowledge About HOTS Mathematics Assessment

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Abstract. Preparing for the implementation of the National Assessment, a test instrument is needed to measure teacher knowledge related to the mathematics HOTS assessment. The aims of this study are 1) to develop an instrument for measure teacher knowledge about HOTS Mathematics Assessment, 2) to produce a valid instrument. Using development research methods Multiple choice test instrument includes 20 questions with 3 dimensions are Definition, Characteristics, and learning of HOTS. Data were collected from 372 mathematics teachers. Technical analysis of data using expert judgment using Aiken's V formula, factor analysis, and confirmatory factor analysis. The results of expert judgment analysis using the Aiken's V formula show that the instrument can be used. Factor analysis shows that 14 items meet and are grouped into 5 factors. Then proceed with the confirmatory factor indicating that the instrument can be used to measure teacher knowledge in the construction of mathematics HOTS test.

Keywords: Development and Validation, Teacher Knowledge, HOTS.

1 Introduction

The rapid development of technology in the era of globalization requires every country to continue to innovate, update and improve all systems, especially education. Education is one way to produce quality human resources. One of the efforts made by the Indonesian government to improve the quality of education is the existence of the National Assessment Program in 2021 [1]. This is in line with the Law of the Republic of Indonesia number 20 of 2003 concerning the National Education System.

In this Ministerial Regulation what is meant by National Assessment, furthermore abbreviated as AN, is a form of evaluation of the education system by the Ministry at the primary and secondary education levels. AN is an assessment program for the quality of schools in Indonesia. AN aims to measure cognitive learning outcomes, non-cognitive learning outcomes, and the quality of the learning environment in educational units [2].

Implementation of AN for Students through minimum competency assessment, character survey, study environment survey and itself adapts from PISA and TIMSS [1]. This indicates that the National Assessment contains questions that require reasoning or can also be called High Order Thinking Skill (HOTS) questions and the construction of the test questions is very closely related to HOTS.

Brookhart said that HOTS is a higher-order thinking ability using knowledge transfer, problem-solving, and critical thinking [3]. Then Bloom has another understanding that HOTS

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is the top thinking ability in the cognitive dimension, namely analyzing, evaluating, and creating [4]. Based on the opinion of experts, it can be concluded that HOTS is a thinking process on the cognitive dimension of analyzing, evaluating, and creating.

HOTS in the assessment has characteristics, as stated by Brookhart that the HOTS assessment has the principle of presenting a stimulus, using new problems, and having different levels of difficulty in each question [3].

The HOTS assessment will be successful if it is supported by learning that uses methods that support the HOTS assessment. For example, problem-based learning, according to research by Hidayati and Retnawati, problem-based learning models are effective in terms of HOTS learning achievement [5].

Through the explanation of HOTS above, of course, HOTS is one of the characteristics of the National Assessment questions. One thing that will be measured in the National Assessment is numeration or math problems [6]. Of course, this must be prepared by the school so that students understand when working on numeracy problems. One of the preparations that must be carried out by schools is that teachers must be given knowledge of National Assessment questions to understand and master them. Because according to research by Heather C. Hill, Brian Rowan, and Deborah Loewenberg Ball, it is stated that teacher's knowledge of mathematics is significantly related to student achievement [7].

This is the background of research to develop instruments to measure teachers' knowledge of HOTS mathematics. As previously stated, the National Assessment contains HOTS questions. So schools must know the extent of their understanding of HOTS mathematics. In addition, it is rare to find an instrument to measure teacher knowledge about HOTS mathematics.

The aims of this study are 1) to develop an instrument for measure teacher knowledge about HOTS Mathematics Assessment, 2) to produce a valid instrument to support the use of an instrument for measuring teacher knowledge about HOTS Mathematics Assessment.

2 Research Methods

1.1. Participants

The sample in this study was taken from 372 high school mathematics teachers who are members of the high school mathematics MGMP members from seven provinces in Indonesia.

1.2. Instrument development

The development of this instrument uses three stages, namely, 1) instrument preparation, 2) content validation by experts, 3) construct validation with EFA followed by CFA. This type of instrument is a multiple-choice test instrument. This instrument has three dimensions, namely definition, characteristics, learning. This refers to the competencies that teachers must have when they want to apply HOTS to mathematics.

Table 1. Aspects of teacher knowledge about HOTS

DIMENSIONS	INDICATOR	ITEM
Definition	Explain the definition of HOTS	1. The following are categories that show higher-order thinking according to Brokhart are... 2. A student cannot automatically recognize the right way to achieve the desired goal, he must

		use one or higher-order thinking processes. This thought process is called... 3. Based on the statements above, which is the understanding of higher-order thinking according to King et al are... 4. In general, HOTS is a thought process that is not just remembering. In Bloom's revised taxonomy, HOTS is thinking at the top three levels of cognitive dimensions. The three levels are...
Characteristics	Describe the characteristics of HOTS	5. Based on the above statement, the characteristics of the HOTS assessment are indicated by... 6. Thinking processes by distinguishing, organizing, and connecting. This statement is a characteristic of HOTS questions at the cognitive level... 7. The process of thinking by examining, refuting, and deciding is a characteristic of HOTS questions at the cognitive level... 8. The process of thinking by generating, planning, and producing. This is a characteristic of HOTS at the cognitive level... 11. The example of the question above is to measure the cognitive level of students at the stage... 12. The example of the question above is to measure the cognitive level of students at the stage... 13. The example of the question above is to measure the cognitive level of students at the stage...
Learning	a) Analyzing basic competencies (KD) to adjust to HOTS-based learning objectives	9. Concerning the 2013 curriculum based on the statement above, things that must be studied regarding the content of HOTs in learning are:... 10. In developing indicators of competency achievement to assess the ability of HOTS. In addition to paying attention to KI, KD, and sentence composition. Teachers should pay attention... 20. Of the several KDs above, which one directly describes HOTS-based competencies?
	b) Explaining learning models that can support	15. According to Anderson & Krathwohl, learning HOTs in the classroom can be realized, teachers can carry out learning with various strategies or varied models. Based on

	HOTS-based learning		the above statement, the learning model that encourages HOTS learning is...
		16.	A suitable learning model to support HOTS-based assessment is….
		17.	To support the HOTS assessment, in learning mathematics the teacher gives a problem at the beginning of learning so that students construct knowledge with discussion and investigation to solve problems. These activities are characteristic of the learning model...
c)	Explain the preparation of HOTS questions for assessment	14.	The first thing that must be considered in preparing questions is...
		18.	The making of HOTS items must provide introductory material such as pictures, graphics, or contextual text by demanding the ability to read at a higher level of thinking. It is called….
		19.	The making of HOTS items has the principle of using new materials. This means that...

Table 1 shows that the definition dimension has 4 questions, the characteristic dimension is 7 questions, and the learning dimension is 9 questions. After the preparation of the instrument is done, the next step is to validate the content with experts and continue with the Aiken's V formula.

Construct validation was carried out in two stages, namely giving instruments to 144 teachers and then analyzing them using EFA. If the results of the EFA analysis have stated that they can be continued, the instrument is given to 228 teachers and then analyzed using CFA.

1.3. Data collection and analysis

The data collection has obtained permission from each head of the high school mathematics MGMP from 7 provinces. Instruments are given using a google form. The MGMP Chair provides a link in the messaging app group. The teachers were asked voluntarily to fill out the instrument. After the teacher fills out the instrument then the data is processed using SPSS 16 for factor analysis (EFA). then continued with CFA using AMOS.

3 Results and Discussion

Content validity is done by expert judgment. Three experts provide a review of the instrument. The study pays attention to three aspects, namely aspects of material, construction, and language. After a study has been carried out, it is then confirmed with Aiken's V. The results of the content validity analysis of the instrument for measure teacher knowledge about HOTS Mathematics Assessment can be seen in table 2.

Table 2 shows that the coefficient of content validity with Aiken's V 0.4 on each item. Based on the content validity criteria with Aiken's V, it can be stated that all items can be used and have quite valid criteria [8].

Construct validation was carried out with exploratory factor analysis (EFA) then followed by confirmatory factor analysis (CFA). In the EFA stage, instruments that have gone through the content validity stage were then given to 144 respondents. The results of the EFA analysis show that the adequacy of sampling shows the Chi-square value in the Bartlet test of 281,556 with 91 degrees of freedom and the p-value shows less than 0.01, namely 0.00. This shows that the sample size of 144 has met the size of the adequacy of sampling. In addition, the results of the sample adequacy analysis are also strengthened by the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) of 0.656 which is greater than 0.5 [9].

Based on the analysis of the adequacy of the sample, it can be concluded that the items in the test instrument can be analyzed further. Furthermore, the results of the analysis of the anti-image correlation value if the value is > 0.5 then the item can be used and if < 0.5 then the item is not used. The anti-image correlation shows that 14 items can be accepted because the anti-image correlation value of each item is more than 0.5 (> 0.5). then 6 items are not used because the anti-image correlation value of each item is less than 0.5 (< 0.5). The 6 items that cannot be used are item 3 with a value of 0.369, item 9 with a value of 0.450, item 10 with a value of 0.348, item 13 with a value of 0.466, item 14 with a value of 0.490, and item 20 with a value of 483. which can be used next are 14 items, namely item 1, item 2, item 4, item 5, item 6, item 7, item 8, item 11, item 12, item 15, item 16, item 17, item 18, item 19, and item 20. Then the number of factors in the results of the EFA analysis can be obtained from the scree plots in Figure 1 [6]. The figure shows that there is a steep one and concludes that there are 5 factors and seen from the agent value of more than 1 (> 1) with an influence of 56.41% percentage value. We named these factors, namely the definition of HOTS (DH) with item 1, item 16, and item 19, Characteristics of HOTS (KH) with item 5, item 6, and item 7, HOTS assessment (PH) with item 4, item 17, and item 18, HOTS Evaluation Assessment (PE) with item 2, item 11, item 18, and HOTS Analysis Assessment (PA) with item 12, and item 15.

Table 2. Aiken's V Score Instrument To measure teachers' knowledge of HOTS mathematics

Item	Aiken's V
1	0,56
2	0,58
3	0,69
4	0,64
5	0,69
6	0,67
7	0,61
8	0,67
9	0,47
10	0,44
11	0,58
12	0,61
13	0,58
14	0,58

15	0,50
16	0,64
17	0,58
18	0,61
19	0,61
20	0,67

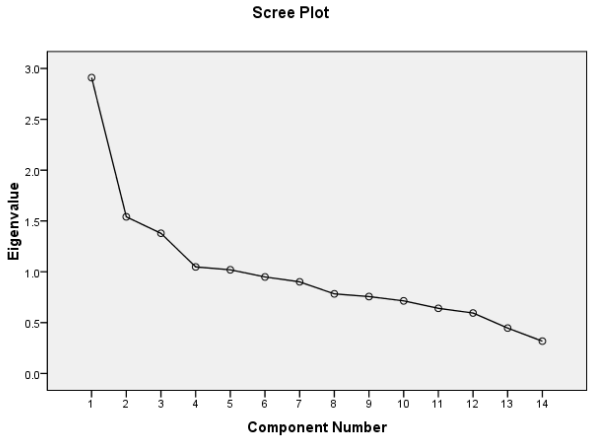

Figure 1. Scree plot EFA instrument for measuring teacher knowledge about HOTS Mathematics Assessment

Furthermore, before moving on to CFA, we first ensured that our data was normal by using maximum likelihood estimation, this method is widely used in structural equation modeling. Research with CFA usually uses the following three to meet the criteria that state the instrument can be used or model fit. Namely 1) non-statistical significance can be seen from the chi-square test value and the root-mean-square error of approximation (RMSEA) value, which is a measure of overall fit, 2) Looking at the t-value compared to the t-table value > 1.96 at the significance level of 0.05. 3) pay attention to parameter estimates with positive or negative coefficients [10]. However, here we only use the first criterion, which is looking at Chi-square, degree of freedom, RMSEA, AGFI, and GFI. The results of a one-time run using AMOS with 228 teacher respondents showed that RMSEA = 0.54, GFI = 0.939, AGFI = 0.905, Chi-Square = 111.823, df = 1.669. If you look at the model fit criteria on Chi-Square and df which is less than 3 (< 3), it can be said that this model has met the model fit criteria. In addition, seeing the RMSEA is between 0.5 and 0.8 then GFI and AGFI are greater than 0.9 (> 0.9) then it can be said that it is also a good fit and it shows that the instrument can be used to measure teachers' knowledge of HOTS mathematics. The purpose of this study is to develop and produce a valid instrument to measure teacher knowledge related to HOTS mathematics. Based on the development process starting from content validation and construct validation, it shows that the instrument is valid and can be used.

Our research theoretically determines that the instrument for measure teacher knowledge about HOTS Mathematics Assessment determines that there are 5 factors, namely the definition

of HOTS (DH), HOTS Characteristics (KH), HOTS Learning (PH), HOTS Evaluation Assessment (PE), and HOTS Analysis Assessment (PA). Then for practical benefits, our research can be used by students for further research related to teacher knowledge about HOTS. Because currently the test instrument for measure teacher knowledge about HOTS Mathematics Assessment is very rare. This instrument can also be used by instructors, supervisors, principals to evaluate teachers, especially mathematics. With the implementation of the AN test program in Indonesia, this instrument is very good for use by school principals, instructors, supervisors to find out the extent of teacher knowledge in dealing with the program.

4 Conclusion

This study development had produced a valid instrument that can be used to measure teachers' knowledge of HOTS Mathematics assessment. This instrument includes 14 items and can be used for further research related to the measurement of teacher competence on mathematics HOTS. The limitation in this study is the number of samples that should be more. Suggestions for further research are that data collection can be done by making training that can be attended by hundreds of teachers as participants.

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