Development Of HOTS-Based Problems Instruments On Class 9 Curved Side Spaces Construction Materials

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Abstrak

Higher Order Thinking Skills (HOTS) siswa di salah satu sekolah negeri kota Semarang masih kurang optimal. Menurut Kurniasih (2020) salah satu cara untuk meningkatan Higher Order Thinking Skills dengan cara membiasakan siswa berlatih soal-soal berbasis HOTS. Oleh karena itu, penelitian ini bertujuan untuk mengembangkan soal-soal berbasis HOTS. Pengembangan ini menggunakan langkah-langkah 4D yang dikembangkan oleh Thiagaraja yaitu pendefinisian, perancangan, pengembangan, dan penyebaran, penelitian ini bertujuan untuk mengembangkan instrumen soal berbasis Higher Order Thinking Skills (HOTS) pada materi bangun ruang sisi lengkung, sehingga dapat menunjang kemampuan HOTS peserta didik. Hasil dari perhitungan indeks kesepakatan yang telah diberikan oleh ketiga ahli diperoleh rata-rata sebesar 0,95. Oleh karena itu, instrumen soal berbasis HOTS pada materi bangun ruang sisi lengkung ini valid dengan indeks validitas sangat tinggi.

Keyword: *Development, Problem Instruments, Higher Order Thinking Skills*

Abstract

Students' Higher Order Thinking Skills (HOTS) in a public school in Semarang are still not optimal. According to Kurniasih (2020), one way to improve Higher Order Thinking Skills is by getting students used to practicing HOTS-based questions to develop students' higher-order thinking skills well. Therefore, this study aims to develop HOTS-based questions. This development uses the 4D steps developed by Thiagaraja, namely definition, design, development, and deployment. This research aims to develop a Higher Order Thinking Skills (HOTS)-based question instrument on curved side geometric shapes, so that it can support students' HOTS abilities. The results of the calculation of the agreement index given by the three experts obtained an average of 0.95. Therefore, the HOTS-based question instrument on curvilinear material is valid with a very high validity index.

Keyword: *Development, Problem Instruments, Higher Order Thinking Skills*

INTRODUCTION

Education in the 21st century primarily forms quality human resources. Quality education will go hand in hand with quality learning. The learning process is a process toward learning objectives that are expected to be meaningful for students during learning. According to Masitoh (2020), one of the main objectives of 21st-century learning is characterized by students' higher-order thinking skills which are increasingly developing and increasing. According to the Ministry of Education and Culture (2017), the ability to think at a high level is one of the assessment standards that is expected to be fulfilled in students during the learning process.

One of the most important skills in the 21st century is *Higher Order Thinking Skills* (HOTS). According to Uswatun and Herina (2019) in the 21st century, the components of critical, creative, collaborative, and communicative thinking as well as having higher-order thinking skills called *Higher Order Thinking Skills* (HOTS) must be prepared by education providers. According to Putu

DOI: https://doi.org/10.26486/jm.v7i2.3288
W : http://ejurnal.mercubuana-yogya.ac.id/index.php/mercumatika
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Manik Sugiari Saraswati (2020), The ability to think of students who not only remember but are also expected to be able to develop ideas is HOTS which must be embedded in students. According to Anderson & Kratwhwol (2001), indicators for measuring *Higher Order Thinking Skills (HOTS)* include analyzing (analyzing-C4), evaluating (evaluating-C5), and creating (creating-C6*)*. Level creation (C6) on HOTS is considered the highest ability that is very important for students to have in the 21st century (Talmi, Hazzan & Katz, 2018; Chalkiadaki, 2018; Saputri et al., 2018).

The analytical aspect involves the ability to break material into smaller parts and find relationships between parts. Meanwhile, the evaluation aspect involves the ability to make decisions, express opinions, or evaluate something using established criteria and standards. In the creative aspect, students can generate new ideas in the context of the material being studied. (Prayitno, Suciyati, & Kusumawardani, 2018). According to Kurniasi (2020) familiarizing students with HOTS-based questions can develop students' higher-order thinking skills well. This activity is not only about providing material, it is also important to prepare evaluation tools to measure HOTS. According to Sa'idah, Yulistiani, & Megawati, (2019) not only through learning activities but the measuring tools that are prepared must also be appropriate so that students have higher-order thinking skills. Meanwhile, according to Arifin & Retnawati (2017) to improve HOTS abilities that exist in students, they can use appropriate learning models and HOTS practice questions.

Learning the 2013 curriculum in the 21st century expects students not only to have lower-order thinking skills or *Lower Order Thinking Skills (LOTS)* but should also be trained to have higher-order thinking skills or *Higher Order Thinking Skills (HOTS)*. In general, all levels of education require students to have higher-order thinking skills (HOTS) as an important value. (Heong et al., 2012; Copley, 2013; Lile & Bran, 2014; Baris, 2015; Saltan & Disvarci, 2017). Education units in Indonesia, especially in Semarang, have implemented the 2013 curriculum since 2014 until now. However, in its implementation, there are still many obstacles, challenges, or problems that arise. As a professional teacher, of course, you have to prepare all the learning processes, including assessments that will be used to find out the results during the learning process. The assessment given should be based on Higher Order Thinking Skills (HOTS). This assessment is carried out to determine the extent to which learning success can improve students' higher-order thinking skills.

The results of an observation that was made with one of the mathematics teachers on October 26 2022 at SMP N 21 Semarang, several students still lacked an understanding of mathematics, especially in the material on curved side shapes. Students have difficulty understanding HOTS-based questions so many student learning outcomes are still below the completeness limit. Therefore learning can be said to be not optimal and students' experience regarding questions based on Higher Order Thinking Skills (HOTS) is also still not optimal. One of the efforts made by the teacher is to give questions based on the Higher Order Thinking Skill (HOTS).

Some previous research related to the development of HOTS-based questions, namely Kurniasi (2020) examined the development of math HOTS measuring instruments for first semester VII graders of junior high school students and obtained valid and reliable HOTS measuring instruments for junior high school students. The results of Israni's research (2022) also show that the development of LKPD based on Higher Order Thinking Skills on the materials for class v elementary school 54 in Banda Aceh has met the valid, practical, and effective criteria. Likewise, research from Masitoh (2020) which examined the development of an assessment instrument for higher-order thinking skills in mathematics in grade VII junior high schools obtained a HOTS assessment instrument that met the criteria of reliability with a reliability coefficient of 0.733. Based on this, the researcher conducted research on the development of a *HOTS-based question instrument* on class 9th-grade curvilinear material. to have higher-order thinking skills.

METHOD

Thiagarajan's (1974) 4D (Four D) model is a development procedure used by researchers in developing this problem instrument. The 4D model consists of four stages of development namely define, design, develop, and disseminate.

A. Defining Stage *(define)*

This stage, namely the defining stage, has the goal of establishing the provisions in learning which include the limits of the material in learning, and the learning objectives on the curved side of the material. The steps taken by researchers are as follows.

1. Beginning-end analysis

The first step that must be taken at the defining stage in this research is that the researcher makes observations on various occasions to find out the initial conditions during the learning process and the researcher can analyze the results of these observations. This is done to know the underlying problem so that researchers can seek solutions to these problems.

2. Student analysis

At this stage, the researcher made observations and examined the characteristics of the students including the initial abilities of the students, especially *HOTS abilities* on curved side geometric shapes. These results will be used by researchers for a diagnosis as material for consideration in developing *HOTS questions* in class 9 class curvature subjects.

3. Material Analysis

The steps that the researcher takes at this stage are identifying, compiling, and detailing regularly the sub-materials of the material to be studied by students, then the sub-materials will be arranged hierarchically. The sub-material used in this research is a sub-material related to curved side shapes.

B. Design stage *(design)*

The purpose of this design stage is to compile and design instruments in the form of *HOTS-based questions.* Activities in this stage consist of three activities, namely: (1) selection of sub-materials, (2) selection of the form of questions, and (3) initial design. Each of the three activities will be briefly described as follows.

1. Sub-material selection

In this activity, the selection of sub-materials will be included in making *HOTS-based questions*. The selection of this sub-material is following material analysis, task analysis, and specification of learning objectives.

2. Selection of question form

The activity at this stage is to determine the form of the questions that will be used to determine *HOTS abilities* by taking into account the initial-end analysis carried out.

3. Preliminary design

HOTS-based questions on curved side building materials for class 9 in the 2013 curriculum.

C. **Development stage *(develop)***

HOTS-based questions on curved side shapes for class 9, the 2013 curriculum which has been revised based on some input from experts and the results of the readability test. The summary of each activity will be explained as follows.

1. Expert validation

HOTS-based question instrument was completed, and in the next stage, content validity was carried out by several people who were considered experts (*expert judgment*). What is meant by experts in this case are validators who are competent to evaluate *HOTS-based question instruments.* Revisions can be made from several suggestions from experts. The steps to prove content validity according to Heri Retnawati (2016), namely: (1) the instrument grid and items, along with the scoring rubric, are given to several experts following the field studied to provide input, (2) input from experts in the form of the suitability of the instrument components with indicators, indicators with items, the correct substance of items, clarity of sentences in items, if it is a test, then the questions must have answers/keys, sentences are not confusing, writing format, symbols, and pictures are clear enough, (3) Based on the expert's input, the grid and/or instruments are then corrected, (4) Asking experts to assess the validity of the items, in the form of conformity between the items and the indicators, this assessment can be carried out using a Likert scale by looking at the relevance as follows.

Table 1. Relevance Criteria

No	Relevance Criteria	Relevance Level
1	$4 < r \leq 5$	Very Relevant

2	$3 < r \leq 4$	Relevant
3	$2 < r \leq 3$	Simply Relevant
4	$1 < r \leq 2$	Less Relevant
5	$0 < r \leq 1$	Irrelevant

After obtaining the assessment results from each expert, the assessment results were processed using Aiken's (1985) formula to obtain the coefficient index as follows.

$$V = \frac{\sum \quad s}{(n(c-1))}$$

Information :

$$s = r - lo$$

lo = lowest rating score (eg 1)
c = highest rating score (eg 4)
r = the number given by the expert

Furthermore, these results are interpreted according to the coefficient index Aiken (1985) as follows.

Table 2. Aiken's coefficient index

No	Validity Criteria	Validity Level
1	$0.8 < V \leq 1$	High Validity
2	$0.4 < V \leq 0.8$	Moderate validity
3	$0 < V \leq 0.4$	Low Validity

D. Disseminate stage

At this stage, the distribution of worksheets that met the valid and practical criteria was carried out to several parties in need, namely at one of the State Middle Schools in the city of Semarang.

RESULTS AND DISCUSSION

HOTS-based question instrument will be presented using a modification from Thiagarajan (1974) as follows.

A. Defining Results

1) Beginning-end analysis

From the results of observations made, the learning process went according to the lesson plans and learning objectives, but at the time of assessment, students experienced difficulties when given *HOTS-based questions*. To overcome this, *HOTS-based question instruments were needed* which had been validated by experts.

2) Student Analysis

The basic abilities possessed by students are still lacking in understanding mathematics, especially in curved side shapes. Students have difficulty understanding *HOTS*-based questions so many student learning outcomes are still below the completeness limit.

3) Material analysis

Based on the results of discussions with colleagues, it obtained sub-materials from the materials of curvature class 9 of the 2013 curriculum, namely: geometric shapes of cylinders, cones, and spheres.

B. Design Results

After analyzing the previous process, namely at the definition stage, a *HOTS-based question instrument* with design planning was developed.

1) Sub-material selection

Based on the results of the material analysis that has been carried out together with colleagues, it is obtained that the sub-materials used in the curvilinear material are cylinder, cone, and spherical geometric shapes.

2) Selection of question form

The form of questions to be used is the form of a description test.

3) Preliminary design

The researcher designed a *HOTS-based problem instrument with* as many as 4 questions

with sub-materials of cylinders, cones, and spheres, while the form of the questions was a description test.

C. Development Results

This development stage includes expert assessment in the form of content validation, which includes questions, grids, scoring rubrics, and validation sheets.

1. Validation results

Based on the validation results from experts on the *HOTS-based question instrument*, the validation results are according to the coefficient index according to Aiken's (1985) with an average of 0.95 so it can be said that the *HOTS*-based questions are very valid, along with the validation results from each expert.

a. First Validator

Dr. Lukman Harun, M.Pd as the first validator said that *the HOTS*-based question instrument was very relevant and appropriate to use with revision. Several revisions can be seen in the following table.

Table 3. First Validator Revision

Question Before revision	Question After revision
a) Pay attention to the use of words, must be consistent in the use of words. b) Pay attention to the font used	a) It has been revised as suggested. b) Already repaired

While the assessment to determine the suitability of items with indicators can use a Likert scale to see their relevance as follows.

No Soal	Skor Relevansi Butir dengan Indikator					Keterangan
	1	2	3	4	5	
	Tidak Relevan	Kurang Relevan	Cukup Relevan	Relevan	Sangat Relevan	
1					√	
2					√	
3					√	
4					√	
Kesimpulan : Sangat Relevan.						

Figure 1. Validation sheet by the first validator

b. Second Validator

Muslih Hasan Pambudi, M.Pd as the second validator said that *the HOTS*-based question instrument was very relevant and appropriate to use with revision. Several revisions can be seen in the following table.

Table 4. Second Validator Revision

Question Before revision	Question After revision
a) Less realistic problems are made even more realistic b) The use of images must be considered again, the line at the end of the cone should be dotted.	a) It has been revised using a more realistic problem b) The image has been fixed

While the assessment to determine the suitability of items with indicators can use a Likert scale to see their relevance as follows.

No Soal	Skor Relevansi Butir dengan Indikator					Keterangan
	1	2	3	4	5	
	Tidak Relevan	Kurang Relevan	Cukup Relevan	Relevan	Sangat Relevan	
1					✓	Revisi sesuai
2					✓	di lember
3				✓		yang direvisi
4					✓	
Kesimpulan :						

Figure 2. Validation Sheet by the second Validator

c. Third validation

Nur Rohman, M.Pd as the third validator said that the HOTS-based question instrument was very relevant and appropriate to use with revision. Several revisions can be seen in the following table.

Table 5. Third Validator Revision

Question Before revision	Question After revision
a) Pay attention to the use of punctuation marks, after the point must be preceded by a capital letter. b) Pay attention to the font used	a) It has been revised as suggested. b) Already repaired

While the assessment to determine the suitability of items with indicators can use a Likert scale to see their relevance as follows.

No Soal	Skor Relevansi Butir dengan Indikator					Keterangan
	1	2	3	4	5	
	Tidak Relevan	Kurang Relevan	Cukup Relevan	Relevan	Sangat Relevan	
1				✓		Perhatikan tanda titik dan koma.
2					✓	
3					✓	
4					✓	
Kesimpulan : LDP						

Figure 3. Validation Sheet by the third Validator

From the relevance assessment given by the three validators, the expert agreement index calculation regarding validity is obtained as presented in the following table.

Table 6. Calculation of Expert Agreement Index

No. question item	Raters			s1	s2	s3	$\sum s$	V
	1	2	3					
1	5	5	4	4	4	3	11	0.91
2	5	5	5	4	4	4	12	1
3	5	4	5	4	3	4	11	0.91
4	5	5	5	4	4	4	12	1

Based on the agreement index calculation table of experts, it was found that number one obtained a validity index of 0.91, number two obtained a validity index of 1, number three obtained a validity index of 0.91, and number four obtained a validity index of 1 so that the average validity index is 0.95.

D. Disseminate results

The diseminate of the questions was carried out on November 16 2022 in class XI F at Semarang City Public Middle School. The students involved in the large-class practicality test were 36 grade 9 students of State Junior High Schools in the city of Semarang. The following is the result of the completion that students wrote.

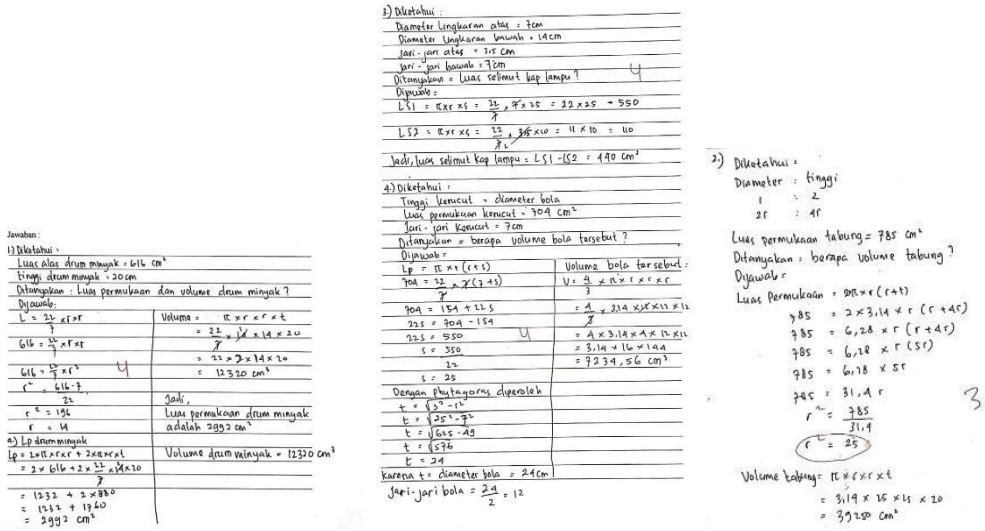

Figure 4. Student Problem Solving

2. Discussion

In the process of developing *HOTS*-based question instruments using Thiagarajan theory with stages consisting of (1) Defining stage, the defining stage will establish and determine the terms of assessment, the form of the questions, and the limits of the material that will be included in the questions. To determine this, pay attention to the initial-end analysis, student analysis, material analysis, task analysis, and specification of learning objectives. (2) The planning stage and the design stage are carried out to design a *HOTS-based question instrument*. Researchers consulted with experts in manufacturing so that they could design *HOTS-based question instruments*. Activities carried out at this stage, namely: selection of sub-materials, selection of question forms, and initial planning of *HOTS-based question instruments*. (3) The development stage produces *HOTS-based question instruments*. The activity carried out at this stage is evaluating the validity of the questions that have been designed by experts to get input and suggestions. After the *HOTS*-based question instrument has been improved, it is hoped that students can understand it.

Based on the expert agreement index calculation table, the validity index is obtained with an average of 0.95. This is in line with research conducted by Kurniasi (2020) which examined the development of a math HOTS measuring instrument for seventh-grade junior high school students in the first semester, which obtained a valid and reliable HOTS measuring instrument for junior high school students. The results of Israni's research (2022) also show that the development of LKPD based on Higher Order Thinking Skills on the materials for class v elementary school 54 in Banda Aceh has met the valid, practical, and effective criteria. Likewise, research from Masitoh (2020) which examined the development of an assessment instrument for higher-order thinking skills in mathematics in grade VII junior high schools obtained a HOTS assessment instrument that met the criteria of reliability with a reliability coefficient of 0.733. Therefore, the *HOTS-based question instrument* on curvilinear material is valid with a very high validity index. It is hoped that the results of the development of the *HOTS* question instrument on the curvilinear material are expected to be able to support students' *HOTS abilities*.

CONCLUSION

This research produced a product of HOTS-based problem instruments on class 9 curved side spaces construction materials. Based on the results of the agreement index calculations that have been given by the three experts, an average of 0.95 is obtained. Broadly speaking, the HOTS-based question instrument on curvilinear material is valid with a very high validity index.

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