

## DEVELOPING HOTS-BASED OPEN ENDED TEST ON GEOMETRY FOR JUNIOR HIGH SCHOOL

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### Abstract

This study aims to develop HOTS-based open ended questions on Geometry material in junior high schools that are standardized based on the criteria of validity, reliability, level of difficulty, and discriminatory power. This research uses Research and Development research type. The research model is modified from the McIntire & Miller model. The research subjects were class VII students at SMP Negeri 2 Pontianak. The instruments used in this research are validation sheets and documentation. Data analysis techniques were carried out quantitatively and qualitatively. Based on the results of the research and discussion it can be concluded that the development procedure includes: 1) defining the test universe, audience, and purpose; 2) developing a plan; 3) conduct pilot test; 4) composing the test items; 5) validation the test; 6) complete the test. The development results obtained 15 item description questions with the results of the analysis including: 1) the reliability of the test was in the very high category, namely 0.95; the validity of the items in the average category is very high, namely 0.71; the average item difficulty level is in the moderate category, namely 0.45; and the discriminating power of the items in the average category is very good, namely 0.43.

**Keywords:** Geometr, HOTS, open ended, development.

### Abstrak

Penelitian ini bertujuan untuk mengembangkan soal open ended berbasis HOTS pada materi Geometri di Sekolah Menengah Pertama yang baku berdasarkan kriteria validitas, reliabilitas, tingkat kesukaran, dan daya beda. Penelitian ini menggunakan jenis penelitian Research and Development. Adapun model penelitian ini dimodifikasi dari model McIntire & Miller. Subjek penelitian adalah peserta didik kelas VII di SMP Negeri 2 Pontianak. Instrumen yang digunakan dalam penelitian ini adalah lembar validasi dan dokumentasi. Teknik analisis data dilakukan secara kuantitatif dan kualitatif. Berdasarkan hasil penelitian dan pembahasan dapat ditarik kesimpulan bahwa prosedur pengembangan meliputi: 1) defining the test universe, audience, and purpose; 2) developing a plan; 3) conduct piloting test; 4) composing the test item; 5) validation the test; 6) complete the test. Hasil pengembangan memperoleh 15 butir soal uraian dengan hasil analisis meliputi: 1) reliabilitas tes berkategori sangat tinggi yaitu 0,95; validitas butir soal rata-rata berkategori sangat tinggi yaitu 0,71; tingkat kesukaran butir soal rata-rata berkategori sedang yaitu 0,45; dan daya pembeda butir soal rata-rata berkategori sangat baik yaitu 0,43.

**Kata kunci:** Geometri, HOTS, open ended, pengembangan



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### INTRODUCTION

In the 21st century, competencies are expected to include: someone who is able to think critically & creatively, has

good communication skills, and can work together. An educational institution is a place for students to explore critical thinking skills, train

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themselves in interacting and collaborating as well as a source of information for students to broaden their horizons so that they are able to shape students in thinking (Bacanli et al., 2011).

Based on the objectives of the mathematics subjects in Permendiknas No 22 of 2006 that students have the ability to: understand mathematical concepts, use reasoning power, solve problems, communicate ideas, and have an attitude of appreciation for the functions of mathematics. To achieve these skills, an assessment concept is needed that is able to describe the expected learning objectives. One of the international standard assessment models is Higher Order Thinking Skills (Chinedu et al., 2015).

In general, in learning mathematics, not many teachers are able to apply the concept of international standard assessment. It became an open secret, even Tandiling (2012) stated that one of the failures of mathematics teachers today is because they are not able to make students think critically and creatively and independently in learning, so most students find it very difficult to absorb and understand mathematics lessons. Some research, Marlina et al., (2018) in Sumatra, Mahanal et al., (2016) in Malang, Fuad et al., (2017) in Kediri, East Java, Setiawati & Corebima (2017) in South Sulawesi, and Asyari et al., (2016), concluded that the thinking ability of students in Indonesia at all levels of education is still low. It is depicted that it is ranked 35th out of 46 countries in TIMSS 2003, ranked 36th out of 49 countries in TIMSS 2007, 38 out of 42 countries in TIMSS 2011, and ranked 44th out of 49 countries in TIMSS 2015 (Rahayu & Dewi, 2022).

Table 1. Average achievement in the cognitive domain

Country	Mathematics Cognitive Domains		
	Knowing	Applying	Reasoning
Indonesia	31	45	24
International Average	64	96	46

Source: TIMSS 2019

Based on the data in table 1 above, Indonesia is below the international average in the cognitive domain. The role of policy makers is very much needed in this case. The Ministry of Education and Culture through the Directorate General of Teachers and Education Personnel organizes the Learning Competency Improvement (PKP) program. One of the PKP programs is a HOTS-based assessment (Setiawati et al., 2019).

The term HOTS for most circles is still quite foreign. The term HOTS began to be widely discussed in 2018 along with the implementation of the National Examination. The reason is that most students think that it is very difficult to answer some questions which require a lot of time and reasoning power to solve. This is because students are not used to answering HOTS-based questions. According to Brookhart in Hidajat (2021) *HOTS is a type of thinking that involves problem solving, critical thinking, reflective, logical, and creative thinking. "HOTS serves to assess whether students already have higher-order thinking skills such as: C4 (analyze), C5 (evaluate), and C6 (create)"* (Abidin et al., 2019).

Based on the researcher's interview with one of the mathematics teachers at public junior high school 2 Pontianak, it was found findings or facts on the ground that the teacher in preparing questions did not refer in detail to the stages of Bloom's taxonomy thinking, especially in the

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realms of C4 (analyzing), C5 (evaluating), C6 (creating). This is illustrated that the questions that have been given have not comprehensively measured students' higher-order thinking skills. Therefore, teachers have a very important role in presenting appropriate learning methods and test instruments to foster higher-order thinking skills in students. Efforts to assess the success of participants in developing higher-order thinking skills are actually supported by measuring instruments that can measure the abilities of these students (Nold, 2017). Teachers are constrained by the basic mathematical abilities of students at public junior high school 2 Pontianak, for example, teachers modify numbers on simple types of questions, sometimes students are still not able to answer. The basic mathematical abilities of students must be instilled from an early age so that it becomes the initial capital to train mathematical abilities at a higher level (critical and creative). Geometry material is considered by researchers to be suitable for developing HOTS-based Open Ended questions at the elementary level, because geometry material at each level in junior high school has a different level of difficulty, so it is hoped that if the VII graders of junior high school are accustomed to solving HOTS-based Open Ended questions then in class VIII and XI is not so difficult for students.

One alternative that can be done to develop students' higher-order thinking skills is to provide a test instrument in the form of HOTS-based Open Ended questions. Open-ended questions are questions for which a number of different and divergent answers can be accepted" (Çakır & Cengiz, 2016). Open-ended questions are seen as effective in developing

students' higher-order thinking skills. According to Feng (2014) Open Ended Questions are effectively used to direct students to think analytically and critically and to test students' understanding and reasoning abilities. This is in line with the research conducted by Mirzaei et al., (2014) by title "Measuring teachers' reflectivethinking skills" states that Open Ended questions are effectively used to measure and can improve and develop thinking skills.

Based on the description above, it is deemed necessary to develop HOTS-based Open Ended questions as an alternative solution to the problems presented by researchers based on experience and interview results. Therefore, researchers are interested in conducting research with the title "Development of HOTS-Based Open Ended Problems in Geometry Materials in Junior High Schools".

## METHOD

This study uses the type of research R & D (Research and Development). Research and development aims to produce new products through the development process (Mulyatiningsih, 2011). This research has various floating models. The research model used in this study is the model developed by McIntire & Miller (2000). In general, this development model stipulates 10 stages which the researcher then simplifies into 6 stages. The ten stages of McIntire & Miller's test development are still explicitly described, but from the researcher's point of view there are several stages that can be combined so that it is possible to classify them into similar stages. As in the stage of writing the administration instructions, there are at least two instructions that must be

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prepared by the test developer, namely: instructions for the organizers and test supervisors and instructions for the test takers themselves. Because the purpose of developing this question is limited to a collection or bank of HOTS-based Open Ended questions, this stage is not a special requirement. As for after the test instrument is standardized and wants to be used by the teacher as a learning outcome test instrument, it is recommended for the teacher to write down instructions that must be prepared by the test developer, namely: instructions for the organizers and test supervisors as well as instructions for the test takers themselves. The conduct item analysis stage is an empirical study by analyzing items quantitatively. The things that are analyzed include the level of difficulty, distinguishing power and the correlation between items. At this stage the researchers combined it into the Conduct piloting test stage, where after the instrument was tested, a quantitative analysis was carried out using Anates Software which resulted in reliability, validity, level of difficulty, and distinguishing power. Likewise, the revising the test stage is also part of this stage. For the stage of developing norms, it is also not a special requirement in this development because once again the purpose of developing the HOTS-based Open Ended question instrument in this study is as a question bank, so researchers do not need to refer to PAN (Normal Benchmark) or PAK (Reference Benchmark). The research subjects in this study were class VII students at public junior high school 2 Pontianak.

Data collection techniques use expert judgment and documentation. The data collection instrument in this study was a validation sheet for multiple choice questions. The validation sheet is

used to obtain data related to the quality of HOTS-based Open Ended questions in geometry material. In developing the questions, content validation will be carried out, namely validation carried out by experts. The documentation in this study is in the form of documents that can support the development of HOTS-based Open Ended questions, including: lesson plans, test results, photographs, etc.

Data analysis techniques include qualitative and quantitative analysis. The stages of qualitative analysis are carried out as an effort to produce valid and reliable instruments. In this step, the validity that is measured is content validity. The instrument that has been revised based on the results of a limited trial is then consulted with the supervisor and then the researcher asks for help from people who are considered experts in mathematics education (validators) to participate in assessing and weighing whether the test instrument made is feasible to use. The quantitative analysis stage is a fundamental part in developing an instrument, namely the instrument is carried out with limited and extensive trials for further analysis using the anates software. The results of the analysis produce test reliability, test item validity, discriminatory power, and level of difficulty.

## RESULTS AND DISCUSSIONS

Research on the development of HOTS-based Open Ended questions in geometry material in Junior High Schools goes through several stages in the development process, including:

### 1. *Defining the test universe, audience, and purpose*

The first stage in this research and development is that the researcher conducts an initial study of the target

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domain of the test, the subject, and the purpose of developing HOTS-based Open Ended questions in geometry material in Junior High Schools. The researcher conducted direct interviews with one of the seventh grade Mathematics teachers at public junior high school 2 Pontianak, namely Mrs. Sri Fitri Aryani, S.Pd. Based on the results of interviews and discussions with Mrs. Sri, it was determined that the test domain that was targeted was the cognitive domain of students. The problem description is considered the right instrument in measuring the cognitive domain of students in terms of solving mathematical problems, especially in HOTS-based Open Ended questions in geometry material. The targets that will be the subject of this research are seventh grade students of public junior high school 2 Pontianak. Based on the results of interviews and discussions, the researcher with Mrs. Sri found the fact that the average mathematical ability of students was still low, most of the students had not been able to solve problems independently even though they had previously been given examples of similar questions. Teachers need extra energy and thoughts just to instill simple mathematical understanding to students, so the questions given tend to be routine questions due to adjustments to the abilities of most students. This condition has been exacerbated by the transition from face-to-face learning to non-face-to-face learning in recent years due to the COVID-19 pandemic.

## 2. *Developing a test plan*

After the information needed at the stage of defining the test was obtained, the researcher continued the activity by planning the test as a whole. Planned things include:

### a. *Analyzing KD (Basic Competencies) that can be made with HOTS-based Open-Ended questions*

Previously, the researcher had discussed with the mathematics teacher at public junior high school 2 Pontianak regarding matters relating to the study of this research, one of which was analyzing the KD in the RPP (Learning Implementation Plan) which was applied to the curriculum at the school. As we know, not all KD can be constructed into HOTS-based Open Ended question models. Based on the results of discussions and studies with the mathematics teacher on the lesson plans used, the KD which is considered appropriate as a reference in the preparation of HOTS-based Open Ended questions is determined. The KD chosen was "Solving contextual problems related to the area and perimeter of rectangles (squares, rectangles, rhombuses, parallelograms, trapezoids, and kites) and triangles".

### b. *Compiling a grid of questions*

The preparation of the grid is an important part in producing a standard instrument, because with a clear and structured grid, the researcher is able to reduce it into a question item by referring to the indicators of competency achievement that have been formulated. Furthermore, the indicators of competency achievement are lowered into question indicators, in this case the question indicators are related to the HOTS indicators. As we know the cognitive domain at the HOTS level is level 3 which includes C4, C5, and C6. Because this question is an Open Ended question, so it does not only refer to the HOTS level but also refers to the Open Ended question type, which has many alternative correct answers.

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*c. Choose an interesting and contextual stimulus*

The stimulus used should be interesting and contextual, meaning that the stimulus is in accordance with the reality in everyday life, interesting, encouraging students to read. In this case, the researcher tries to arrange editorial questions that are relevant to everyday life.

*d. Write question items according to the question grid*

The questions are written in accordance with the rules for writing HOTS-based Open-Ended questions. The rules for writing HOTS-based questions for Open Ended items are somewhat different from the rules for writing items in general. Here, the researcher shows an example of a question item in Figure 1.

<b>QUESTION CARD NUMBER 1 (ESSAY)</b>	
Subjects	: Mathematics
Class/Semester	: VII/ Even
Basic competencies	Solve contextual problems related to the area and perimeter of rectangles (squares, rectangles, rhombuses, parallelograms, trapezoids, and kites) and triangles
learning materials	Quadrangle (Square and Rectangle)
Question Indicator	An illustration is presented, students are able to detect problems regarding the area of a rectangular flat shape
Cognitive Level	L3 (C4-Analyze)
<b>Question</b> It is known that the area of a rectangle is 220 cm <sup>2</sup> . Find the length and width of the rectangle and how!	

Figure 1. HOTS based open ended question cards

*e. Creating scoring guidelines (rubric)*

Each item of HOTS-based Open Ended questions written should be accompanied by a scoring guide or answer key. Scoring guidelines are made for the form of description questions. In addition to preparing several alternative answers for each item as an answer key, the researcher also made general scoring guidelines. Here, the researcher presents the scoring guidelines for the description questions. The scoring guidelines are used by researchers in scoring each student's answer, so that the score obtained by each student will be measured. This measurability also has an impact on the analysis of each item.

**3. Conduct piloting test**

After all the test instruments have been compiled, the next step is to try the test instruments on a small scale. The subjects used as samples in conducting this limited trial were some of the seventh grade students of SMPN 2 Pontianak who were taken at random by 17 students (13 female and 4 male). This limited trial was conducted on Monday, May 23, 2022 for 2 hours. The items tested on the students were 15 items of description on geometry material. As for some of the devices at the limited trial stage including: question grids, question cards along with alternative answers, and scoring guidelines are in Appendix A. After students complete the trial, then the

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results of the trial are processed and analyzed quantitatively using Anates

Software. The result of data analysis can be seen in Table 2.

Table 2. Summary of Item Analysis Results in Limited Trials

No	Reliability	Validity	Difficulty level	Distinguishing Power	Decision
1		Very High	Medium	Good	Used
2		Medium	Medium	Good	Used
3		High	Medium	Good	Used
4		High	Medium	Enough	Used
5		Very Low	Medium	Not Good	Used, many revision
6		Very Low	Medium	Not Good	Used, many revision
7		High	Medium	Very Good	Used
8	Very High	Medium	Medium	Not Good	Used, slightly revised
9		High	Medium	Good	Used
10		Medium	Medium	Enough	Used
11		Medium	Medium	Enough	Used
12		High	Medium	Very Good	Used
13		Low	Difficult	Enough	Used, slightly revised
14		High	Medium	Enough	Used
15		Medium	Medium	Enough	Used

Based on the analysis of item validity, reliability, discriminatory power, and item difficulty index, it can be concluded whether the items made meet the indicators of accuracy or not and need to be revised or not. Table 15 shows the results of the decision that items 5 and 6 can be used with many revisions, while items 8 and 13 can be used with a few revisions. For items number 1, 2, 3, 4, 7, 9, 10, 11, 12, 14, 15 can be used without revision.

#### 4. Composing the test items

The next stage is that the test items are re-validated with the assessment criteria that will be carried out by the validator. The content validation step is carried out to see the suitability of the questions made with the grid, alternative answers and scoring guidelines, as well as to see whether the items made have met the characteristics of the HOTS-based Open Ended questions. For the purposes of content

validation, three people who are considered experts as validators were selected, namely one internal campus mathematics education lecturer, one campus external mathematics education lecturer, and one mathematics teacher.

The things validated by the validator generally include aspects of language, material, and construction. The conclusions drawn from the content validation results consist of three categories, namely questions suitable for use for trials without revisions, questions suitable for use for trials with few revisions, questions suitable for use for trials with many revisions, and questions not suitable for testing.

The validators provide conclusions at the end of the validation stage according to the existing categories based on the review criteria that have been given. The results of the content validation of the item items can be seen in Table 3.

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Table 3. Conclusion of content validation results

No	Validator I				Validator II				Validator III			
	1	2	3	4	1	2	3	4	1	2	3	4
1	-	-	-	√	-	-	-	√	-	-	-	√
2	-	-	-	√	-	-	-	√	-	-	-	√
3	-	-	-	√	-	-	-	√	-	-	-	√
4	-	-	-	√	-	-	-	√	-	-	-	√
5	-	-	√	-	-	-	√	-	-	-	-	√
6	-	-	√	-	-	-	√	-	-	-	-	√
7	-	-	√	-	-	-	-	√	-	-	-	√
8	-	-	-	√	-	-	-	√	-	-	-	√
9	-	-	-	√	-	-	-	√	-	-	-	√
10	-	-	-	√	-	-	-	√	-	-	-	√
11	-	-	-	√	-	-	-	√	-	-	-	√
12	-	-	-	√	-	-	-	√	-	-	-	√
13	-	-	√	-	-	-	√	-	-	-	√	-
14	-	-	-	√	-	-	-	√	-	-	-	√
15	-	-	-	√	-	-	-	√	-	-	-	√

Information:

- 1: the questions are not suitable for testing
- 2: the questions are suitable for testing with many revisions
- 3: the questions are suitable for testing with a few revisions
- 4: the questions are suitable for testing without revision

### 5. Validation the test

After revising, the next researcher conducted a test validation study by conducting trials on a larger scale. This method of measuring validity is called criterion validity using the concurrent validity technique. The test questions are declared reliable if the scores are

always consistent or fixed after being used several times on the same subject but at different times.

The subjects used as samples in conducting this broad trial were all students of class VIIG SMPN 2 Pontianak a total of 30 students consisting of 17 women and 13 men. This extensive trial was conducted on Friday, 27 May 2022 for 2 hours or 2 x 40 minutes. The items tested on the students were 15 items of description on geometry material. After the students complete the trial, then the results of the trial are processed and analyzed quantitatively using the Anates Software. The results of the trial analysis can be seen in Table 4.

Table 4. Summary of Item Analysis Results in the Extensive Trial

No	Reliability	Validity	Difficulty level	Distinguishing Power	Decision
1		High	Medium	Enough	Used
2		Very High	Medium	Very Good	Used
3		High	Medium	Very Good	Used
4	Very High	High	Medium	Very Good	Used
5		High	Medium	Very Good	Used
6		High	Medium	Very Good	Used
7		Medium	Medium	Good	Used
8		High	Medium	Very Good	Used

No	Reliability	Validity	Difficulty level	Distinguishing Power	Decision
9		High	Medium	Very Good	Used
10		High	Medium	Very Good	Used
11		Very High	Medium	Very Good	Used
12		High	Medium	Very Good	Used
13		Very High	Difficult	Good	Used
14		High	Medium	Very Good	Used
15		Medium	Difficult	Enough	Used

### 6. Complete Test Manual

Based on the analysis of item validity, reliability, discriminatory power, and item difficulty index, it can be concluded whether the items made meet the indicators of accuracy or not and need to be revised or not. Table 5 shows the results of the decision that all items were declared qualified as standard instruments so that they were suitable for use.

This research and development resulted in HOTS-based Open Ended questions on geometry material in junior high schools that had met the requirements of a standard instrument, namely in terms of reliability, validity, discriminating power, level of item difficulty. This research and development produces a product in the form of a question grid, question cards and alternative answers, scoring guidelines, and question items. The questions developed refer to the geometry material in class VII SMP where the questions are developed in the form of description questions. The number of questions developed there are 15 items in the form of descriptions that have referred to the HOTS-based Open Ended indicators which include the cognitive domains C4 (analyzing), C5 (evaluating), C6 (creating). The HOTS concept used in this study refers to the concept of higher order thinking in the revised Bloom's Taxonomy.

The developed questions have been analyzed qualitatively and quantitatively and are declared to have met the standard instrument requirements so that they are feasible to use. Validation of the HOTS-based Open Ended question instrument uses logical validation which includes aspects of material, construction and language analyzed according to the validator's assessment. The researcher's findings at the validation stage by experts should be items that become indicators of expert assessment of the test instrument referring to the theory which states the question contains elements of Open Ended based on HOTS, so that it will be clearer in the determination by the validator that the question is included in the Open Ended question. HOTS based. As for the quantitative analysis at the instrument testing stage, in order to make it more optimal, the research subject should be adjusted to the characteristics of the research, namely seeing the ability of students who are accustomed to questions that are at a high-level thinking level.

Students are not used to working on HOTS-based Open Ended questions, this is also emphasized by the mathematics teacher at the school that for routine questions, sometimes students have difficulty working on them. The low results of working on HOTS-based Open Ended questions for students are influenced by several

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factors, one of which students are not accustomed to working on HOTS questions (Tanujaya et al., 2017; Yusuf & Widyaningsih, 2019). This is a finding for researchers so that it is expected to be a reflection for teachers to as early as possible get students to work on questions that are able to hone higher-order thinking skills. They need to practice in developing HOTS by referring to HOTS-based learning resources. To realize and develop HOTS in themselves, students are required to be more active in learning (Yusuf & Widyaningsih, 2019). Lecturers are also expected to act as facilitators who provide various learning resources and provide feedback on student assignments (Masruroh & Prasetyo, 2018). HOTS of students can also be increased through the provision of assignments and exercises in the learning process (Istiyono et al., 2018; Yusuf & Widyaningsih, 2018). On this basis, it is very important to train students' HOTS by developing HOTS-based Open Ended questions.

This research is in line with research conducted by Wulandari, (2021) with the title "Development of mathematics learning tools with an Open Ended approach to develop higher order thinking skills (HOTS) for junior high school students" explaining that the validity of learning tools is very good, the practicality of learning tools is very high. good, the test results show that the average HOTS mastery of students is in the good category so that it can be said that the device that has been developed is feasible to implement. The importance of developing HOTS-based Open Ended questions as an effort to improve the quality of students so they can think at a high level and be able to solve math problems through problem solving (Safitri, 2020).

The results of the development of the HOTS-based Open Ended test instrument indicate that the quality of the validity is in the high category, the average validity of the items is 0.71. The average level of test reliability is in the very high category, namely 0.95, so it can be concluded that the item has a very strong level of reliability. The average discriminatory power of the items is 0.42, which means it is in the very good category. The average level of item difficulty is 0.45, which means it is in the medium category. Based on the results of the analysis of these items, the 15 HOTS-based Open Ended description items that have been developed are declared to be usable.

## **CONCLUSIONS AND RECOMMENDATIONS**

Based on the results of data analysis on the development of HOTS-based Open Ended questions in geometry material in Junior High Schools, it resulted in 15 essay questions which were stated to be suitable for use with the results of the item analysis including: test reliability was in the very high category, namely 0.95; the average item validity is in the high category, namely 0.71; the average item difficulty level is in the medium category, namely 0.45; and the discriminating power of the items on average is in the very good category, namely 0.43. The findings of the researcher at the expert validation stage should be the items that serve as indicators of the expert's assessment of the test instrument referring to the theory which states that the question contains HOTS-based Open Ended elements.

Recommendation for future researchers, in the testing phase of the instrument so that it is more optimal, the

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research subject should be adjusted to the characteristics of the research, namely looking at the ability of students who are familiar with questions that are at a high-level thinking level.

## REFERENCES

- Abidin, A. Z., Istiyono, E., Fadilah, N., & Dwandaru, W. S. B. (2019). A computerized adaptive test for measuring the physics critical thinking skills. *International Journal of Evaluation and Research in Education*, 8(3), 376–383. <https://doi.org/10.11591/ijere.v8i3.19642>
- Asyari, M., Muhdhar, M. H. I. Al, Susilo, H., & Ibrohim. (2016). Improving criticalthinking skills through the integration of problem-based learning and group investigation. *International Journal for Lesson and Learning Studies*, 5(1), 36–37.
- Bacanli, H., Dombayci, M. A., Demir, M., & Tarhan, S. (2011). Quadruple thinking: Creative thinking. *Procedia - Social and Behavioral Sciences*, 12, 536–544. <https://doi.org/10.1016/j.sbspro.2011.02.065>
- Çakır, H., & Cengiz, Ö. (2016). The Use of Open Ended versus Closed Ended Questions in Turkish Classrooms. *Open Journal of Modern Linguistics*, 06(02), 60–70. <https://doi.org/10.4236/ojml.2016.62006>
- Chinedu, C. C., Olabiyi, O. S., & Kamin, Y. (2015). Strategies for improving higher order thinking skills in teaching and learning of design and technology education. *Journal of Technical Education and Training*, 7(2), 35–43.
- Feng, Z. (2014). Using Teacher Questions to Enhance EFL Students' Critical Thinking Ability. *Journal of Curriculum and Teaching*, 2(2), 147–153. <https://doi.org/10.5430/jct.v2n2p147>
- Fuad, N. M., Zubaidah, S., Mahanal, S., & Suarsini, E. (2017). Improving junior high schools' critical thinking skills based on test three different models of learning. *International Journal of Instruction*, 10(1), 101–116. <https://doi.org/10.12973/iji.2017.1017a>
- Hidajat, F. A. (2021). Students creative thinking profile as a high order thinking in the improvement of mathematics learning. *European Journal of Educational Research*, 10(3), 1199–1213.
- Istiyono, E., Dwandaru, W. S. B., Megawati, I., & Ermansah, M. (2018). *Application of Bloomian and Marzanoian Higher Order Thinking Skills in the Physics Learning Assessment: an Inevitability*. 164(Icli 2017), 136–142. <https://doi.org/10.2991/icli-17.2018.26>
- Mahanal, S., Zubaidah, S., Bahri, A., & Dinnurriya, M. S. (2016). Empowering students' critical thinking skills through Remap NHT in biology classroom. *Asia-Pacific Forum on Science Learning and Teaching*, 17(2), 1–13.
- Marlina, L., Liliyasi, Tjasyono, B., & Hendayana, S. (2018). Improving the critical thinking skills of junior high school students on Earth and Space Science (ESS) materials. *Journal of Physics: Conference Series*, 1013(1).

DOI: <https://doi.org/10.24127/ajpm.v12i1.6132>

- <https://doi.org/10.1088/1742-6596/1013/1/012063>
- Masruroh, A. N., & Prasetyo, Z. K. (2018). Effect of E-Module with Guided Inquiry Approach Containing Nature of Science to Student's Science Literacy. *E-Journal Pend. IPA*, 7(3), 165–171.
- McIntire, S. A., & Miller, L. A. (2000). *Foundations of psychological testing*. McGraw-Hill.
- Mirzaei, F., Phang, F. A., & Kashefi, H. (2014). Measuring Teachers Reflective Thinking Skills. *Procedia - Social and Behavioral Sciences*, 141, 640–647. <https://doi.org/10.1016/j.sbspro.2014.05.112>
- Mulyatiningsih, E. (2011). *Terapan Riset*. Yogyakarta: UNY Press.
- Nold, H. (2017). Using Critical Thinking Teaching Methods to Increase Student Success: An Action Research Project. *International Journal of Teaching and Learning in Higher Education*, 29(1), 17–32.
- PERATURAN MENTERI PENDIDIKAN NASIONAL REPUBLIK INDONESIA NOMOR 22 TAHUN 2006.
- Rahayu, B. N. A., & Dewi, N. R. (2022). Kajian Teori : Kemampuan Berpikir Kritis Matematis Ditinjau dari Rasa Ingin Tahu pada Model Pembelajaran Preprospec Berbantu TIK. *PRISMA, PROSIDING SEMINAR NASIONAL MATEMATIKA*, 5, 297–303.
- Safitri, A. E. (2020). *Pengembangan Soal Open-Ended pada Mata Pelajaran Sejarah Kebudayaan Islam Materi Dinasti Abbasiyah Berbasis Higher Order Thinking Skill (HOTS) di MAN 1 Jepara*. Universitas Islam Nahdlatul Ulama Jepara.
- Setiawati, H., & Corebima, A. D. (2017). Empowering Critical Thinking Skills Of The Students Having Different Academic Ability in Biology Learning of Senior High School through PQ4R - TPS Strategy. *The International Journal of Social Sciences and Humanities Invention*, 4(5), 3521–3526. <https://doi.org/10.18535/ijsshi/v4i5.09>
- Setiawati, W., Asmira, O., Ariyana, Y., Bestary, R., & Pudjiastuti, A. (2019). Buku Penilaian Berorientasi Higher Order Thinking Skills. In *Kementerian Pendidikan dan Kebudayaan*. <https://doi.org/10.37411/pedagogika.v10i2.60>
- Tandiling, E. (2012). PENGEMBANGAN INSTRUMEN UNTUK MENGUKUR KEMAMPUAN KOMUNIKASI MATEMATIK, PEMAHAMAN MATEMATIK, DAN SELF-REGULATED LEARNINGSISWA DALAM PEMBELAJARAN MATEMATIKA DI SEKOLAH MENENGAH ATAS. *Jurnal Penelitian Pendidikan*, 13(1).
- Tanujaya, B., Mumu, J., & Margono, G. (2017). The Relationship between Higher Order Thinking Skills and Academic Performance of Student in Mathematics Instruction. *International Education Studies*, 10(11), 78. <https://doi.org/10.5539/ies.v10n11p78>
- Wulandari, E. (2021). *Pengembangan perangkat pembelajaran matematika dengan pendekatan*

DOI: <https://doi.org/10.24127/ajpm.v12i1.6132>

*open ended untuk  
mengembangkan higher order  
thinking skill ( HOTS ) siswa  
SMP. 4(1), 30–37.*

Yusuf, I., & Widyaningsih, S. W.  
(2018). Profil Kemampuan  
Mahasiswa Dalam Menyelesaikan  
Soal Hots Di Jurusan Pendidikan  
Fisika Universitas Papua. *Jurnal  
Komunikasi Pendidikan*, 2(1), 42.  
[https://doi.org/10.32585/jkp.v2i1.  
63](https://doi.org/10.32585/jkp.v2i1.63)

Yusuf, I., & Widyaningsih, S. W.  
(2019). HOTS profile of physics  
education students in STEM-  
based classes using PhET media.  
*Journal of Physics: Conference  
Series*, 1157(3).  
[https://doi.org/10.1088/1742-  
6596/1157/3/032021](https://doi.org/10.1088/1742-6596/1157/3/032021)