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Development of a HOTS Indicator Availability Test Instrument for Instructional Media

Miftahurrahmi*, Fanny Rahmatina Rahim, Silvi Yulia Sari, Murtiani
Departement of Physics, Universitas Negeri Padang, Jalan Prof. Dr. Hamka, Air Tawar Padang 25131, Indonesia

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ABSTRACT

The 21st century demands reforms in education, especially in developing HOTS abilities. Based on observation data at SMAN Kota Padang, students' learning achievements that contain HOTS indicators have not been implemented well. The solution is to develop an instrument to test the availability of HOTS indicators in learning media. The research aims to produce an instrument for the availability of HOTS indicators in learning media. The development model for this research is the ADDIE model (analysis, design, development, implementation and evaluation). The use of the ADDIE development model is only limited to the development stage. The first stage is to conduct a needs analysis through questionnaires and interviews. The second stage is designing instrument indicators. Next, instruments are developed based on indicators. The third stage is testing the validity of the instrument. The instrument was validated by three experts from Physics lecturers at Padang State University. The results of the validity test obtained a valid instrument. Therefore, this instrument is suitable to be used to analyze the availability of HOTS indicators in the media.

***Correspondence:**
Miftahurrahmi , Departement of Physics, Universitas Negeri Padang, Jalan Prof. Dr. Hamka, Air Tawar Padang 25131, Indonesia
email : rahmimiftahur206@gmail.com

INTRODUCTION

The 21st century demands various reforms, especially in the 2013 curriculum into the revised 2013 curriculum. The revised 2013 curriculum requires students to be active and able to develop the ability to think critically, objectively, systematically, chronologically and creatively in learning, especially physics lessons.(Hartono, R., & Pahlevi, T, 2020). High-level thinking abilities (HOTS) are an important aspect of the learning process (Tanujaya, B, 2016). HOTS is also the ability of students to solve a problem by connecting concepts, ideas or ideas through reasoning, interpretation, decision making so that they are able to solve problems and find new methods (Baidlowi, M. H., Sunarmi, S., & Sulisetijono, S, 2013). Bloom's

taxonomy of high-level skills includes C4-C6 skills, namely analyzing, evaluating and creating (Ariyana, Y., Pudjiastuti, A., Bestary, R., & Zamroni, Z, 2018) .Students have high-level thinking skills in obtaining information through the process of analyzing, synthesizing information, and evaluating the information obtained (Wardani, A. N. U., & Ibrahim, M, 2020).

The results of the 2018 Program for International Student Assessment (PISA) show that the PISA results are low because assessments that integrate HOTS are still low. This problem is proven by Indonesia being ranked 72nd out of 77 countries (Schleicher, A, 2019). This also happens because students are still not used to solving problems that use a high level of reasoning and analysis (Wulandari, S., Hajidin, H., & Duskri, M, 2020). The government requires learning to use high-level thinking competencies. Learning that uses HOTS skills in the learning process is centered on students or is active during learning activities (Ernawati, E, 2016). For this reason, HOTS is very important, because students not only understand the material but apply it in everyday life (Karsono, K, 2017).

If HOTS is good, then everyday problems can be interpreted and formulated in the form of questions. Efforts that can be made to hone students' abilities are that learning resources are needed which contain elements of HOTS indicators in them. HOTS indicators include abilities in problem solving, decision making, critical thinking and creativity (Wahyuni, D. E., & Arief, A, 2015).

The results of observations at SMAN Kota Padang obtained data in the field regarding HOTS abilities. It can be seen that 49% of students are only able to formulate problems in physics learning clearly, 51% of students are only able to analyze physics problems well, 53% of students are only able to limit the problems. problems and think creatively to find solutions, and 50% of students are able to test the hypothesis of a physics problem.

The explanation above shows that students' learning achievements that contain HOTS indicators have not been implemented well. The solution to this problem is to develop an instrument to test the availability of HOTS indicators in learning media. The instrument that will be developed is very important because it can determine the extent to which HOTS indicators are available in the learning media that teachers will implement in the learning process, because the assessment of student learning achievement is always changing. (Tanujaya, B, 2016). The instrument that will be developed will also explain the results of the validation of the instrument that has been created, whether it is suitable for use or not.

Based on these problems, the author feels it is necessary to develop an instrument to test the availability of HOTS indicators. The instrument material that will be developed is physics material for class X semester II. The results of the instruments that have been developed can be used by teachers or other researchers in developing a good HOTS-based product that meets the demands of the 21st century.

METHODS

The research aims to produce an instrument from the availability of HOTS indicators in learning media. This research is development research (research and development) (Fitriani, H., Asy'ari, M., Zubaidah, S., & Mahanal, S, 2019). This type of development is used in the education sector to validate instruments or products that will be produced in the education sector (Haryati, S, 2012). The development model used is ADDIE (Analysis, Design, Develop, Implement, Evaluate)(Gibbons, A. S., Boling, E., & Smith, K. M, 2014). Researchers used this model until the development stage in developing instruments based on the availability of HOTS indicators.

The analysis stage is the first stage in the research which is carried out by analyzing the need to find out whether the development of instruments based on the availability of HOTS

indicators in learning media needs to be carried out or not. Preliminary study by distributing questionnaires to SMAN students throughout Padang City. The next step is material analysis, material analysis is carried out from the results of the 2019 high school physics exam scores.

The second stage is design, at this research stage is to first design an instrument grid which includes HOTS indicators and criteria for good learning media based on existing theoretical studies. After forming the instrument grid, an instrument for the availability of HOTS indicators in learning media was developed. This instrument will later be used to see the availability of HOTS indicators in the learning media used.

The third stage of development is the stage of developing HOTS indicator test instruments for learning media. This stage is carried out by validating the instrument, revising the instrument, so that the final product is produced in the form of an instrument that can be used to analyze the availability of HOTS indicators in learning media. Instrument validation uses three validators whose function is to test the feasibility of the instrument that has been created. The statement on the validation sheet consists of eleven statements. The choice scale on the validation sheet consists of strongly agree (score 5), agree (score 4), neutral (score 3), disagree (score 2), strongly disagree (score 1). The results of filling in the validation sheet will be tested using the Aiken V formula equation(H. Retnawati, 2016).

$$V = \frac{\Sigma s}{[n(c-1)]} \quad (1)$$

$$(s = r - I_0) \quad (2)$$

The Aiken V equation is the number of scores selected by each validator lecturer minus the lowest result divided by the number of categories minus one and multiplied by the number of validators. The Aiken V Index value ranges from 0-1 which can be categorized in Table 1(Retnawati, H, 2016).

Table 1. Aiken V Index Criteria

Intervals	Category
V ≤ 0,4%	Kurang valid
0,4% < V < 0,8%	Valid
V > 0,8%	Sangat valid

Analysis of the instrument validity test results was carried out after validation tests were carried out by 3 validators. Whether the instrument validation test results are valid or not can be analyzed using the Aiken V formula. After validation, several instruments are revised based on comments and suggestions from the validator. After revisions have been made, the instrument is shown again to the validator and it is acknowledged that the instrument is suitable for use.

RESULTS AND DISCUSSION

The research that has been carried out produces a product in the form of an instrument for the availability of HOTS indicators in learning media in the form of power points from several stages, namely.

Analysis Phase

The aim of the analysis stage is to analyze the need for test instruments for the availability of HOTS indicators in learning media. The analysis stage can also be carried out

through distributing questionnaires and direct interviews with teachers. Based on the results of the questionnaire, mastery of high-level thinking skills is still categorized as low. This data can be seen in the students' ability to solve the 2019 National High School Physics National Exam questions in Padang City based on HOTS, MOTS and LOTS levels in Table 2 (Puspendik, 2019).

Table 2. Students' Ability to Solve National High School Physics 2019 National Examination Questions in Padang City Based on Level (HOTS, MOTS, LOTS)

No.	High School Name	Percentage (%)		
		HOTS	MOTS	LOTS
1	SMA Negeri 1 Padang	84.3 %	87.2 %	87.6 %
2	SMA Negeri 2 Padang	60.3 %	55.0 %	80.0 %
3	SMA Negeri 3 Padang	55.6 %	53.4 %	70.4 %
4	SMA Negeri 4 Padang	47.0 %	45.9 %	72.2 %
5	SMA Negeri 5 Padang	45.9 %	43.2 %	60.3 %
6	SMA Negeri 6 Padang	45.9 %	47.1 %	62.3 %
7	SMA Negeri 7 Padang	41.5 %	39.3 %	65.9 %
8	SMA Negeri 8 Padang	52.6 %	43.2 %	65.1 %
9	SMA Negeri 9 Padang	47.4 %	48.1 %	57.1 %
10	SMA Negeri 10 Padang	65.7 %	66.5 %	79.8 %
11	SMA Negeri 11 Padang	40.0 %	29.8 %	51.9 %
12	SMA Negeri 12 Padang	44.0 %	45.6 %	61.4 %
13	SMA Negeri 13 Padang	36.0 %	31.9 %	53.3 %
14	SMA Negeri 14 Padang	50.0 %	39.8 %	71.4 %
15	SMA Negeri 15 Padang	44.3 %	38.1 %	51.0 %
16	SMA NEGeri 16 Padang	43.6 %	35.9 %	49.3 %

Table 2 shows that the number of UN physics questions in 2019 is based on the cognitive level explained in Table 1, namely that there are 14 HOTS questions or 35%, 18 MOTS questions or 45%, and 8 LOTS questions or 20%. The results of the average value obtained are the percentage of questions that students are able to answer. This data analysis was carried out for all high schools in Padang City. So, based on data analysis of students' National Examination scores, it can be concluded that the HOTS percentage of State High Schools in Padang City is categorized as still low.

The results of interviews and teacher questionnaires on average still do not fully implement HOTS with students. Then the learning media often used by technology-based teachers is Power Point media. At this stage of analysis, it was found that no one had yet developed an instrument to test the availability of HOTS indicators for physics learning media. Apart from that, this stage produces HOTS indicators which can later be developed in learning media.

Design Stage

This stage produces an initial design of the HOTS indicator instrument. The first step is to design an instrument grid based on research variables, namely learning media and HOTS indicators. There are several sub-variables in learning media variables, namely: (1) material substance including indicators of correctness, up-to-dateness and readability; (2) display (communication and visual) with indicators in the form of navigation, typography, media and layout; (3) learning design includes title indicators, core competencies (KI) and basic competencies (KD), indicators, learning objectives, materials, example questions, exercises,

evaluation/simulations, organizers, and instructions; (4) use of software with interactivity indicators, supporting software(Wibawanto, H., & Sahid, S, 2010). The results of the HOTS indicator availability test instrument for learning media are in Table 3.

Table 3. HOTS Indicator Availability Test Instrument for Learning Media

Sub Variable	No	Instrument Items
Material Substance	1	The material in learning media (MP) does not deviate from the truth of science.
	2	The material presented is factual so that it can increase students' understanding.
	3	Material is in accordance with the principles and laws that apply in physics.
	4	Materials always develop along with developments in science and technology.
	5	The MP presented uses standard grammar.
	6	The MP is presented using language that is easy to understand.
Display (Communication and Visual)	7	Using basic navigation on MP is working well.
	8	The proportion between the size of the letters and the slide space on the MP is correct.
	9	The color combination in MP is interesting.
	10	The images presented in the MP correspond to the learning material.
	11	The quality of the illustrations in the MP in the form of pictures and animations in terms of placement, size and color is correct.
	12	The forms of icons, symbols and buttons used are systematic.
	13	The audio presented in MP supports learning.
	14	Videos according to learning material.
	15	Animation in accordance with learning material.
	16	Interesting MP skill design.
Design	17	The title corresponds to the learning material.
	18	The formulation of Core Competencies (KI) in MP is in accordance with Content Standards.
	19	The formulation of Basic Competencies (KD) in MP is in accordance with Content Standards.
	20	The indicators presented in the MP correspond to the KD.
	21	The learning objectives in MP are in accordance with the indicators.
	22	Learning materials are in accordance with KI and KD.
	23	The sub-material presented in the MP is explained with example questions.
	24	Example questions according to learning indicators.
	25	Examples of questions presented in the MP include discussion of the questions.
	26	The practice questions presented in the MP correspond to learning indicators.
	27	The evaluation questions presented in the MP are in accordance with the material.

Sub Variable	No	Instrument Items
	28	All questions presented at the MP are accompanied by discussion of the questions.
	29	There is a drafting identity in the MP.
	30	Instructions for using MP are clearly explained.
Utilization of Software	31	MP is equipped with practice questions that can provide feedback to users (students).
	32	MP raises motivation to learn.
	33	MP makes students active in reconstructing their knowledge.
	34	MP can be accessed directly via computer or smartphone.
	35	MP can operate well.
Solution to problem	36	MP facilitates paying attention to the problems presented.
	37	MP facilitates in limiting the problems that have been formulated.
	38	MP guides students to formulate problems clearly.
	39	MP facilitates students to reveal the causes of the problems given.
	40	MP facilitates students to formulate hypotheses.
	41	MP facilitates students to find the necessary data.
	42	MP facilitates students grouping data needed for problem solving.
	43	MP facilitates testing hypotheses by processing the information obtained.
	44	MP facilitates in describing recommendations for completion according to the results of hypothesis testing.
	45	MP guides students to determine options for solving the given problem.
	46	MP guides in solving existing problems.
	47	MP guides students in drawing conclusions based on the data that has been collected.
Decision-making	48	MP facilitates students to analyze the causes of the given problem.
	49	MP facilitates students to identify the impacts caused by a given problem.
	50	MP facilitates students to identify several possible decision alternatives that can be used in solving problems.
	51	MP facilitates students to make decisions to resolve the problems given.
	52	MP facilitates students to provide reasons for choosing this alternative solution.
	53	MP facilitates students predicting the impact of decision-making actions from solutions used to solve physics problems in real contexts.
	54	MP facilitates students to assess the advantages and disadvantages of the resulting physics problem solving decisions.

Sub Variable	No	Instrument Items
Critical thinking	55	MP guides students to understand the meaning of pictures, graphs, diagrams, tables and paragraphs.
	56	MP guides students to state the meaning of an image, graph, diagram, table and paragraph.
	57	MP guides the grouping of data from the observations obtained.
	58	MP guides students to express the results of their thoughts as a solution to a problem.
	59	MP proves the truth of the information obtained.
	60	MP asked to evaluate the truth of the information obtained.
	61	MP guides students to draw conclusions from the information obtained.
	62	MP measures students' abilities from general to specific.
	63	MP measures students' abilities, starting from specific to general.
Think creatively	64	The problems presented in MP can educate students to provide a variety of answers based on physics problems correctly.
	65	Problems in MP can be solved in different ways and have the correct value.
	66	MP guides students in producing various answers.
	67	MP guides students to develop an idea.
	68	MP guides students to detail the details of an object
	69	MP is able to encourage students to create their own thoughts through a problem.
	70	MP guides students to be able to create new expressions or terms.

Table 3 contains HOTS indicator variable with four HOTS indicators(S. Wulandari, H. Hajidin, and M. Duskri, 2020) namely: 1) problem solving skills in the HOTS indicator. In problem solving skills, several sub-indicators are obtained, including: formulating, analyzing, formulating hypotheses, collecting data, testing hypotheses, and determining solution options.(A. D. S. B. and Zain, 2001); 2) decision making skills are one indicator of HOTS. Decision making skills have several sub-indicators including: analyzing the causes of problems, identifying the impacts of problems, identifying decision alternatives, making decisions, giving reasons, predicting the impact of decision making, and giving an assessment of decisions. (Woolever, R. M. and Scott, K. P, 1988); 3) critical thinking skills with sub-indicators, namely: analyzing, evaluating, concluding, deductive and inductive (Wulandari, S, 2021); 4) creative thinking skills on the HOTS indicator with sub-indicators including: fluency, flexibility, elaboration, originality. After the grid has been designed, an instrument can be developed to see the availability of HOTS indicators in learning media with 70 instrument items. Instrument items from items 1-35 are variables for learning media. The learning media instrument items are useful for seeing whether the learning media used by the teacher is in accordance with the correct learning media rules or not. Then instrument items 36-70 are variables for the HOTS indicator. The development of the HOTS indicator instrument is very important in analyzing whether the learning media used includes HOTS indicators properly or not. The development of HOTS indicators is also useful for developing products that integrate HOTS indicators. The material that will be analyzed in developing

the test instrument for the availability of HOTS indicators in it is high school physics material for class X semester II.

Development Stage

The development stage is a stage in developing a HOTS indicator availability test instrument product. Instruments that have been developed from the instrument grid will be subjected to instrument validation tests by three validator lecturers. This aims to see the validity of the instrument, whether it is worthy of development or not.

The development of instruments on material substance sub-variables contains indicators of scientific truth. The truth of science contains rules that are in accordance with science and whose truth is tested based on existing facts. Then the material coverage indicator contains the completeness of the material presented, exploration or development, collaboration with other materials. The next indicator is contemporary, with the aspect studied being actuality seen in terms of material, up to date or using application examples based on actual conditions, and the material presented must be innovative. Lastly, the readability indicator examines the standard language used and whether the language is easy to understand or not.

Instrument development on display indicators (communication and visual) with navigation instrument items with a study on navigation is to use navigation buttons that are appropriate and function well. Then the letters seen are the proportionality and composition of the letters. The next indicator is media, where the aspect studied is the suitability of the image to the learning material, then the quality of the image presented, then the icons, audio, video and animation used must be in accordance with the learning material presented. The design appearance of the learning media must be attractive and appropriate to the learning material.

Learning design indicators include aspects of suitability of title, KI and KD, indicators, learning objectives, example questions, and exercises with learning materials. The learning media design contains the identity of the composer and instructions for using the learning media. The next indicator is interactivity in the use of learning media. Interactive learning media contains practice questions that create reciprocal interactions with students. Then learning media can increase students' learning motivation. Development of instruments for HOTS indicators which include problem solving skills, decision making, critical thinking and creative thinking. Indicators of problem solving skills, namely formulating problems with instrument items, are paying attention to problems in physics material, limiting problems to physics material, formulating problems clearly and precisely. Then the next indicator analyzes the problem with instrument items revealing the cause of the existing problem. The next indicator is formulating a hypothesis, collecting data, testing the hypothesis, and determining settlement options (A. D. S. B. and Zain, 2001)

The indicator of decision making skills with the instrument item is analyzing the causes of problems given in physics material. Then the instrument items identify the impact of a given problem, identify decision alternatives that might be used, then make a decision based on the problem, providing reasons for the decision taken. The final instrument item of decision-making skills is predicting the impact of decisions taken and providing an assessment of the results of decisions that have been taken . (Woolever, R. M. and Scott, K. P, 1988).

The indicator of critical thinking skills has several instrument items, namely analyzing with an explanation of the instrument items. Analyzing is understanding, stating the meaning, and grouping data in the form of images, tables, or paragraphs. Then the instrument items evaluate by explaining the instrument items, namely stating the results of thoughts, proving the truth, and evaluating the truth obtained from the information

obtained. The next instrument item summarizes the information obtained, deductive means measuring students' abilities from general matters and specific conclusions, and inductive means measuring students' abilities from specific matters to general conclusions (Wulandari, S, 2021).

Indicators of creative thinking skills with the instrument item fluency, namely providing a variety of answers to physics problems that are given correctly, then flexibility, namely solving physics problems in different ways and with correct value, producing a diversity of answers by linking previous material. The next instrument item is elaboration, namely developing ideas and detailing an object in physics material. Lastly, the originality instrument item is creating one's own thoughts through existing problems and being able to give birth to new expressions or terms. The learning media variable has 4 sub-variables including material substance, appearance, design and use of software. The statements on the validation sheet are in Table 4.

Table 4. Instrument Validation Sheet

No	Assessment Components
1	The validity instrument is in accordance with the objectives to be achieved in the research
2	The instrument covers all material in interactive learning media for class X semester II which will be analyzed
3	The instrument has clear instructions for use
4	The instrument is easy to use in the assessment process
5	The instrument display has clear readability
6	The instrument can reveal the quality of the availability of HOTS indicators in interactive learning media, thereby allowing suggestions for improvement
7	The instrument can reveal the quality of material presentation in interactive learning media based on HOTS indicators, thereby allowing for suggestions for improvement
8	The instrument can reveal the presentation of material on interactive learning media which refers to problem solving indicators, thereby allowing suggestions for improvement
9	Instruments can reveal the presentation of material in interactive learning which refers to indicators of decision-making skills, thereby allowing for suggestions for improvement
10	Instruments can reveal the presentation of material in interactive learning which refers to indicators of critical thinking, thereby allowing suggestions for improvement
11	Instruments can reveal the presentation of material in interactive learning which refers to indicators of creative thinking, thereby allowing suggestions for improvement

The instrument validation sheet statement in Table 4 will be filled in based on a predetermined scale. The scale specified on the instrument validation sheet uses a Likert scale with a range of 1-5. Score 1 is in the strongly disagree category, score 2 is in the disagree category, score 3 is in the neutral category, then score 4 is in the agree category, and score 5 is in the strongly agree category [19]. The average validation results of the validation instrument sheet by the validator fill in a score range of 4 and 5. The validation results can be stated in the category of valid or not after the validation results are obtained in accordance with the specified criteria. The results of instrument validation based on three validators using the Aiken V equation in formulas (1) and (2) are obtained in Table 5.

Table 5. Instrument Validation Sheet Processing Results

Scale	Validator 1	Validator 2	Validator 3	s1	s2	s3	Σs	V
Item 1-15	51	42	48	40	31	37	108	0,82

The validation results of the test instrument for the availability of HOTS indicators in learning media at SMAN Kota Padang received a validation result of 0.82 or 82% with a very valid category. This figure shows that the HOTS indicator availability test instrument can be used.

CONCLUSION

The results of research regarding instrument development show that the instrument developed is declared very valid with a figure of 82%. Sub variables that will be validated are regarding material substance, appearance, design, use of software and HOTS indicator skills. The instrument will be validated on the validation sheet that has been provided regarding the content and clarity of the language of the instrument for the availability of HOTS indicators in the learning media. Furthermore, this instrument can be used to analyze the availability of HOTS indicators in learning media. This instrument can be a basic instrument for analytical research or initial research into the development of learning media.

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