JISAE ICERE
Journal of Indonesian Student Assessment and Evaluation
The 2nd International Conference on Educational Research and Evaluation
https://doi.org/10.21009/JISAE
JISAE (Journal of Indonesian Student Assessment and Evaluation)
ISSN : P-ISSN: 2442-4919 | E-ISSN: 2597-8934
Website : http://journal.unj.ac.id/unj/index.php/jisae
Vol 9 No 2 (2023)

THE DEVELOPMENT OF ASSESSMENT INSTRUMENT OF REASONING ABILITY ON HOTS FOR PHYSICS LEARNING

Yetti Supriyati [1]
[1] Program Pascasarjana, Universitas Negeri Jakarta.

Address for Correspondence:
yeti.supriyati@unj.ac.id

ABSTRACT

The purpose of this study is to develop an assessment instrument of reasoning ability on HOTS-based science learning assessment model on the Primary School Education Program's students. The research method used is a research and development method. This method developed the evaluation model of HOTS-based science learning assessment that has the characteristics to measure the ability of deductive hypothesis between variables, to predict phenomenom represent it with logical thinking. Moreover to analyze theoretical statement by using if-then provison. HOTS-based science learning assessment model is validated by physics education experts and science education practitioners. After that, the assessment tools were tested by students in the Primary School Education Program. The result showed that the assessment model has 7 items characteristic deductive hypothesis that valid and reliable.

Keywords: development of assessment tool, science learning, deductive hypothetical, HOTS, Higher order thinking skills

INTRODUCTION

Natural Sciences (science or science) as a subject that must be studied at every level of education that has a strategic role in the formation of formal thinking patterns for each student. As one of the essential lessons in school especially at the basic level, science learning must be carried out in accordance with the nature of science learning and the purpose of science learning. Mastery of concepts, processes, and products, as well as the scope of material about adequate science learning, will be beneficial for a teacher and prospective teacher. Therefore it is necessary to increase the ability to weight the curriculum, the quality of the teaching staff, and learning techniques in an effort to improve the quality of learning outcomes and assessment of learning. This must be owned by every educator and prospective educator so that it is expected to be able to create human resources who have adequate attitudes, skills, and knowledge. In science learning, the teacher must know the concept of science learning so that learning is fun and the assessment of learning is authentic. Thus science is not sufficiently understood from the dimensions of scientific products in the form of facts, concepts, principles, laws, and theories about the universe, but must also include the process of structuring knowledge or thinking patterns along with the assessment model & attitudes that accompany scientists' work.

Science learning is very important & especially for improving thinking skills starting from the elementary level up to the basic education teacher prospective students. Some of the important thinking skills for science learning include critical, creative, divergent thinking, deductive hypotheses, and science process skills so that students can explore various natural phenomena around them. The introduction of science to basic education is very necessary to develop the ability about (2): (1). Exploration and investigation, namely activities to observe and investigate objects and natural phenomena; (2). Develop basic science process skills, such as making observations, measuring, communicating observations and so on; (3).

Develop curiosity, pleasure and conduct inquiry or discovery activities; (4). Understand the knowledge of various objects, both characteristics, structure, and function.

According to the American Association of Physics Teacher [3] " important role holders of education quality are teachers". This means that the teacher is the key to the quality of education. Prospective teacher students must be prepared to become professional educators so that the learning process runs optimally. As prospective educators, students must have competence. in accordance with the Indonesian National Qualifications (KKNI), the competencies of students must have high-level thinking skills or Higher Order Thinking Skills (HOTS) which are optimally developed.

Cognitive processes and representations can be divided into two continuous parts: (1) lower order cognition (LOC), which is the component that lies at the beginning of cognitive processes and is still superficial, such as perception, pattern recognition, and memory. (2) higher order cognition (HOC), that is, components that lie in the final or higher order of the entire human cognitive process, for example thinking, concept formation, reasoning, language, decision making, and problem-solving [4]. Whereas according to Rosnawati [5] critical thinking is one of the high-level thinking processes that can be used in forming student conceptual systems. So, critical thinking is the main component in HOTS.

HOTS according to Yee Mei Heong, et al. [6] is an important aspect of the learning process. Students with high-level thinking skills are able to learn, improve their performance and reduce their weaknesses. Students or students are required to think higher. They not only memorize but also understand and apply their knowledge. They must be able to analyze, be critical, creative and able to reason at the formal level.

According to Piaget [7], there is five kind of reasoning formal which develops at the level of thinking of formal operations. Mastery of five types of reasoning he is a very good predictor in determining formal reasoning in the fields of science and mathematics is proportional, combinatorial thinking, controlling variables, deductive and reflective hypotheses.

In the United States, Guana Mwarda [8] found that only a small proportion of students and their adults were tested had reached the formal operational stage. This finding may have been related to Piaget's theory of formal operational thinking, which describes certain types of thought processes. Therefore a formal reasoning knowledge is improved for students. Students who have been classified as formal operational stages can understand and answer correctly the questions related to problem-solving, which even though they have never been taught about it. In other words, it can be stated that students who have entered formal operations will have proportional, combinatorial reasoning, variable control, deductive and reflective reasoning abilities.

In research concerning formal reasoning for solving problems observing mathematical thinking students aged 14-16. The results of the study indicate that students are interested in to begin the problem-solving process at the highest level and instead have difficulty transitioning from low to higher levels of activity. Qualitative analysis reveals the preferences of some students from the use of formulas, while at the same time other students show insights with their systematic approach to the problem, which leads to better outcomes. For this reason, it is hoped that matching formal valuation modeling emerges in teaching formal reasoning, stimulating students to create knowledge relational networks. As prospective educators, prospective teacher students must be able to solve problems in educating or teaching children, for that formal reasoning at a higher level of thinking ability (HOTS) must be honed before entering the field [9].

In connection with this problem, there are several studies on formal reasoning. The first study conducted by Stephen [10] on learning mathematics and science found that many

students could apply numerical approaches but could not apply multiplication structures related to their formal reasoning. Each child will be faced with various concepts such as speed, density, distance traveled by a car gasoline, and various units of numbers. The second study conducted by Lay Yoon Fah [11] found that students' logical thinking ability was still low, with the average score of percentages for all reasoning lower than the overall average. In addition, this study also revealed that there were 98% of respondents in the concrete operational stage while the other 2% were categorized in the transition stage.

Furthermore, it was also found that there was no significant difference in a person's thinking ability based on his sex [12]. The concept of ratio and comparison are widely applied in mathematics, science and every life. Formal reasoning is also used in reading maps, making estimates of distances using the scale on a map. Besides that, it was found that an important characteristic of formal reasoning is that it involves reasoning about the holistic relationship between two rational expressions such as rates, ratios, comparisons and fractions [13]. This study found that in developing science and mathematics learning there needs to be a design in the learning experience that is focused on the cognitive and affective domains of children. In addition, there needs to be a variety of teaching methods that can be given because students have a variety of different abilities. Kathrin and Peter [14], stated that there are still many students who have enough difficulty in applying to reason to ratios or products of two quantity variants, namely a number that is comparable or inversely proportional to another one.

Formal reasoning regarding reflective thinking refers to Dewey's opinion [15], to be able to think we are trying to see what is indicated as a possibility or possible outcome. Thinking is considering what attitudes occur, but not yet. According to Dewey reflection is an affirmation of the relationship between what will try to do something with the consequences that occur. Reflection as acceptance of responsibility for future consequences that will occur from the actions taken.

In higher education institutions, assessments are generally carried out through process assessment, assignments, midterms, final semester examinations, and practice and attendance. As a student teacher who will later enter the world of education in teaching, it is certainly expected to have a good ability to think or formal reasoning, where students are required to understand in variations and comparisons that will be useful in the practice of activities in basic education, especially regarding science learning. The description of HOTS, science learning, and the results of research conducted by a number of researchers, shows that there are no studies that have made specific HOTS assessment models related to formal reasoning.

Based on the results of observations made, the reality in the field proves that the assessment carried out in the course is still fixated on the assessment of the exam results such as midterms, final semester examinations, assignments and practices carried out on students. As a prospective educator-student must be able to solve problems that will be faced in teaching at school later, especially in teaching the early age in the golden age. Students are required to have the ability to teach science to students in elementary school. The form of assessment is limited to understanding the material taught by the lecturer. Lecturers tend to judge ignoring reasoning processes in students who take lectures, as for how daily practices are carried out in learning. Therefore, to further enhance HOTS's ability regarding formal reasoning in students, researchers tried to make a HOTS-based science learning assessment model related to thinking of a deductive hypothesis.

But what happens in elementary school is learning is still slow, the media used is less varied, the class atmosphere is not conducive. In addition, a scoring system that only considers aspects of understanding, without seeing aspects of thinking or reasoning. The aspect of formal reasoning for students, especially students of the PGSD study program,

received little attention. This problem a solution is needed that can be a solution, the researcher is interested in producing a valuation model that can measure HOTS's ability to learn science, especially in PGSD study programs that are in line with the IQF. In this study, the researchers attempted to develop a HOTS-based science learning assessment model in the form of formal reasoning, including the ability to think of deductive hypotheses of PGSD students. The valuation model is designed according to Piaget's formal theory of reasoning with due regard to the Indonesian national qualification framework (KKNI).

METHODS

This study aims to develop a model of science learning courses at PGSD in shaping HOTS capabilities which include thinking of deductive hypotheses, based on the framework of Indonesia's national qualifications in science learning courses. This research was conducted at the PGSD FIP, Jakarta State University, located in Jakarta. The subjects in this study were students who were taking courses in the basic concepts of science. The choice of subject is based on a consideration and based on needs analysis because in Jakarta State University it does not have a valuation model that can measure formal reasoning about students' deductive hypothesis thinking in the field of science.

Preliminary research was carried out to describe the condition of the students carried out by observation techniques. This is done to measure HOTS including the ability to think of deductive hypotheses with indicators on each student because students are already at the stage of formal thinking, which is very useful in the future if the students' formal reasoning can develop well. Besides that, a literature study was conducted as a supporter of modeling. The results of this research stage are the assessment models in shaping the student's formal reasoning so that it is valid and reliable. Based on the results of field observations and literature studies arranged 10 items in the form of essays with analytic assessment rubrics.

The research method used in this research is research & development (modification and development) modification of the model according to Borg and Gall which aims to develop science learning assessment models ranging from design, product validation by experts, validation by pre-practitioners until field trials have achieved a valid and reliable assessment model. Research & development is a bridge between basic research and applied research that aims to find knowledge that can be practically applied.

Data analysis is done by combining quantitative and qualitative data. Qualitative data was used to get an overview of the validity level & the evaluation model developed was reviewed by expert judgment including linguists, PGSD experts, and science learning experts. Furthermore, the results of the expert review are reviewed by practitioners and followed by calculations with the quantitative low she formula. Next, the stages of testing on PGSD students then obtained a valid and reliable valuation model.

a. Expert Review

The expert review was conducted to analyze the suitability of items with conceptual indicators of the 10 items that have been arranged. In addition, the suitability of items in construction can measure precisely what is to be measured, namely the relationship between variables, can be mapped using logic, can predict using the provisions if / then, and the theoretical provisions become conditions to determine the predictions contained in the instrument grid. Besides that, a language suitability study was conducted with the respondents. Expert review for science material is carried out by science learning experts. The expert review results as a theoretical review stage of the assessment instrument thinking the deductive hypothesis is carried out qualitatively and quantitatively. The results of expert analysis regarding the accuracy of the items with indicators in the form of

qualitative descriptions containing suggestions for improvement. Furthermore, the revision of the assessment model is based on the results of expert validation by describing the data from expert validation descriptively so that the expert validation results obtained from the assessment model think the deductive hypothesis in the SCIENCE learning in PGSD. The valuation model thinks the deductive hypothesis is made in scientific material about straight motion. Expert review was conducted by 3 (three) qualitative Physics Education experts. Experts review construct the essay item with a rubric analytical assessment. and the language validation used is whether it uses a language based on the characteristics of a deductive hypothesis that has an indicator of relations between variables, can be mapped using logic, can predict using the provisions if / then, and theoretical provisions become a condition for determining predictions.

b. Practitioner Study

After the expert review was carried out, it continued with the study of PGSD lecturers in the field of science learning as practitioners who rated a total of 19 people. The feasibility of the essay items to be given to PGSD students includes the items to assess the thinking of the deductive hypothesis, in the study of SCIENCE in PGSD. At this stage, FGDs were carried out by practitioners to study and provide input on the items in the essay. Review results through FGD practitioners the first gives an overview in accordance with the essay items so that the items that are worthy to be used are obtained, the two items that are deemed feasible, can be used with a revision of the item first, and the third items that are deemed not suitable to be disposed of and do not need to be used in the next phase of testing. Furthermore, the results of the review through the FGD are input considered in the revision of the assessment model. The valuation model for measuring thinking of the deductive hypothesis with physical material about straight motion is obtained by 10 items of essays that are qualitatively valid.

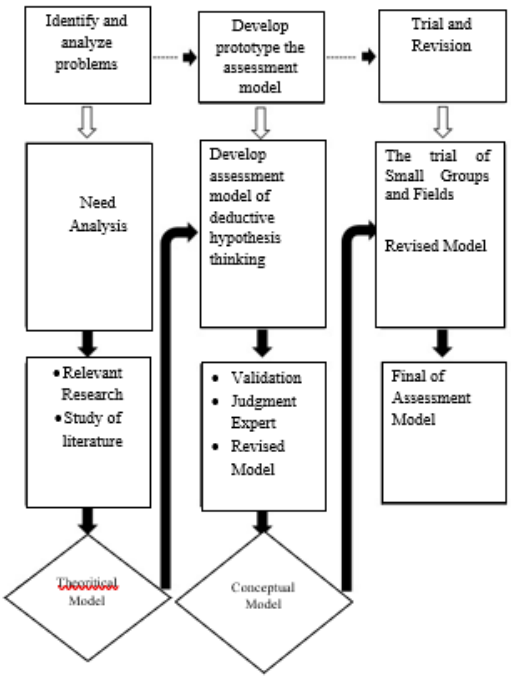

Figure 1. Research Flow Chart

Based on the consideration of the experts and FGD practitioners on the design of the questions in the form of a description wherein in this study questions were developed for the material of Straight Motion including Analyzing the physical quantities in motion with

constant speed and acceleration used as an assessment of science learning. The flow chart is in Figure 1.

c. *The trial of Small Groups and Fields*

At this stage, the first trial was conducted in a small group of 5 PGSD students to work on the revised questions. In small-scale trials obtained the ability to think of deductive hypotheses for indicators of relationships between variables, can be mapped using logic, can predict using the provisions if / then, and theoretical provisions to be a condition for determining predictions. Then it was tested on 20 respondents. The results of this field trial with questions in the form of description with rubric analytic assessment are used as an assessment of learning in the material of Straight Motion.

RESULT AND DISCUSSION

a. Expert Review

The expert review assesses three aspects of assessment, namely construction, substance, and language. Based on the assessment category, namely 0% - 25%: Not Good, 25.1% - 50%: Poor, 50.1% - 75%: Good, 75.1% - 100%: Very good, validation results by material experts (Table 1) in terms of construction reached 89.58%, the substance was 96.86% and the language was 90.62%. The results of the validation by the evaluation expert obtained an average percentage of the assessment of all aspects was 92.35%. This shows that the questions in terms of the aspects of construction, substance, and language have a very good category.

Table 1. Results of Expert Review Validation

No	Aspect Rating	Overall Percentage (%)	Interpretation
1	Construction	89,58	Very good
2	Subtitles	96,86	Very good
3	Language	90,62	Very good
Average Percentage		92,35	Very good

Description:
0% - 25% : Not Good
25,1% - 50% : Enough
50,1% - 75% : Good
75,1% - 100% : Very Good

b. Material Study Expert

Validation by material experts is carried out by practitioners aimed at correcting the problem if there are errors and misconceptions about the questions developed from the aspect of construction, substance & language as an assessment of learning. The material experts involved were PGSD lecturers. The assessment was given through a material expert validation questionnaire. The bar chart from the results of the validation test as an instrument for assessing science learning by material experts is in Figure 2.

Based on the results of the validation by material experts, the average percentage of the overall aspects was 92.35%. This shows that the questions in terms of the aspects of construction, substance, and language have very good interpretations. From these results, it can be stated that the learning assessment model developed is appropriate to be used in the assessment of science learning at PGSD.

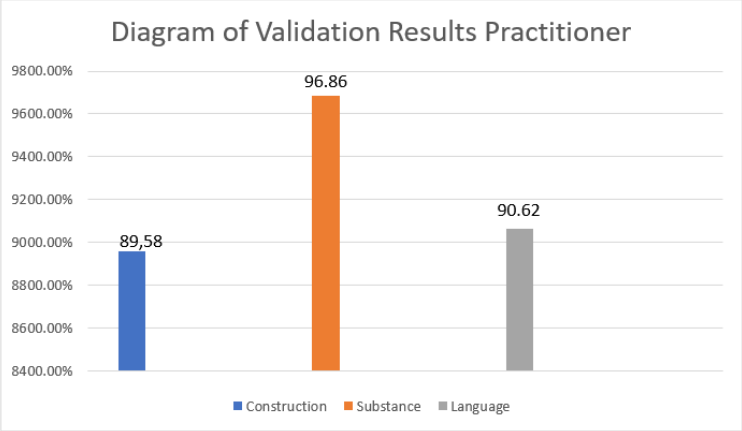

Figure 2. Bar Diagram of Validation Results Practitioner

Description:
0% - 25% : Not Good
25,1% - 50% : Enough
50,1% - 75% : Good
75,1% - 100% : Very Good

Small Group and Field Trials

The next step is to get a good question, then the question tested first. This trial is carried out in students PGSD S1, the tested instrument in the form of a description-based test HOTS specifically thinks the deductive hypothesis is 10 items.

The results of the trial data are then analyzed which includes the validity test, reliability test, distinguishing power and level of difficulty. So that there are valid test questions and reliable. Analysis of validity, reliability, differentiation, and level of difficulty was carried out on each item by using Microsoft Excel software. The results of the recapitulation of validity, distinguishing power and the level of difficulty of each item in Table 2.

Number	Validation		differentiating power		level of difficulty		Result
	Score	Category	Score	category	Score	Category	
1	0,14	Invalid	0,03	less distinguishing features	0,63	Medium	Discarded
2	0,44	High	0,20	Good	0,65	Medium	Valid
3	0,44	High	0,28	Good	0,81	Easy	Valid
4	0,53	High	0,16	less distinguishing features	0,47	Medium	Discarded
5	0,57	High	0,29	Good	0,61	Medium	Valid
6	0,44	High	0,36	Good	0,70	Easy	Valid
7	0,70	Very High	0,38	Good	0,56	Medium	Valid
8	0,21	Invalid	0,09	less distinguishing features	0,06	Difficult	Discarded
9	0,45	High	0,29	Very Good	0,30	Difficult	Valid
10	0,76	Very High	0,59	Very Good	0,67	Medium	Valid

Table 2. Recapitulation of Trial Results Problem

Based on Table 2, it can be seen that 80% of the questions are valid with 25% very high categories; 75% high category; 0% enough category. While 20% of the other questions are categorized as invalid. Based on the differentiating power, the questions that meet the criteria are 70% with 20% very good categories and 50% good categories, while 30% of the questions have less distinguishing features. Based on the level of difficulty as much as 20% about the easy category, 60% medium category and 20% difficult category.

The technique used to determine the reliability of the test is to use the Cronbach Alpha formula (r11). Based on the calculations performed, the value of the reliability of the questions is 0.852. This value can be categorized as a very high-reliability test so that it can be said that the instrument used has a very good regularity. After analyzing the results of the instrument trials, there are several questions that are discarded. Of the 10 questions tested there are 3 questions that fall, namely numbers 1, 4 and 8. So the problem is used are 7 questions.

Discussion

a. Research Introduction

In general, in the form of essay writing questions are always guided by steps or rules of writing in general, for example, referring to the test grid that has been made and the purpose of the problem is clear. In developing a question in the form of a description, the problem must already have an idea of the scope of the material that is asked and the scope of the expected answers, depth, and length of the answer, or the details of the answers that may be given by students [16]. In other words, this scope is the criteria for the extent or extent of the problem being asked. This must be clear and clearly illustrated in the formulation of the problem. With the limitations of the scope, the possibility of unclear questions can be avoided. In addition, the writing of item description has fulfilled the criteria, namely 1) Questions in accordance with indicators, 2) Limitations of expected questions and answers accordingly, 3) Materials asked in accordance with the objectives of measurement, 4) Content of material asked in accordance with education level, 5) Using question words or commands that require description answers, 6) There are clear instructions on how to work on the problem, 7) There are guidelines for scoring, 8) Tables, images, graphics, presented clearly and legibly, 9) Formulation of communicative sentence sentences, 10) Question items use standard Indonesian. The scope will also help facilitate the making of scoring criteria or guidelines.

Instrument questions that have been developed are then made scoring guides. Scoring alloys meet continuum assessment rules using the analytical assessment rubric. This assessment rubric refers to the scoring guidelines for questions in the form of objective description (BUO). The objective description problem is a question or question that demands a set of answers with certain definitions/concepts so that scoring can be done objectively [17].

In this study, there were four types of data collected, namely material expert validation data, expert validation, small group test, and field test. Data obtained from the results of the validation of material experts and practitioners used as a reference to revising the assessment model before testing it with students.

The HOTS assessment instrument was developed in accordance with Piaget's theory of the deductive hypothesis phase, which starts with a statement in the form of a question of cause [18]. Students are asked to formulate possible answers (hypotheses) to the question. Then students are asked to reduce the logical consequences of hypothetical hypotheses and plan and conduct experiments to test hypotheses (exploration). Then students can draw conclusions systematically or conclude which patterns are applied in solving problems. Based on the synthesis of the theory, think the proof hypothesis must meet the indicator there is a relationship between variables in each item, can be mapped using logic, can predict using the terms " if " " then ", and theoretical provisions are the main conditions for determining predictions.

Furthermore, the indicator "can be mapped using logic". The HOTS description questions above have been developed using very simple and very systematic sentences. So that students who are solving it can map into their logic and pour it into sketches and

drawings. The data for each Triyaningsih exercise is data that students can map into their logic.

Then for the indicator "can predict using the terms " if " " then " in each item about". In the question about the HOTS developed above the syllogism theory has implied " if ", " then". Students will be able to correctly solve the above problems by proving: if the data on Tryaningsih training time is faster than the data of the world's fastest running record, Triyaningsih can break the latest record in a 100-meter sprint run.

The last indicator is "theoretical provisions are the main conditions for determining predictions". In the first part of the HOTS description above mentioned a little about the theory used in constructing the items, namely the theory of straight motion. This indicator is indicated by the sentence 'Triyaningsih running in a straight line". Running in a straight line shows that the question is a matter in the material of Straight Motion.

b. Expert Review

Based on the results of the expert validation the material shows the results of the assessment which is included in the very category both (aspects of accuracy) and good (aspects of suitability and language). This shows that the questions developed for the valuation model reviewed from the aspect of the accuracy of suitability and language by having a very good category. From this result, it can be stated that the problem which was developed properly to be used as an assessment of science learning in PGSD to assess thinking skills in the HOTS category. The suggestions given are as follows:

1. Use more contextual units and numbers
2. Fix typing and language that is still not right
3. Consider the time students use to work on the problem

c. Material Study Expert

From these results, it can be stated that the learning assessment model developed is appropriate for use in the assessment of learning physics. At the end of the validation questionnaire, material experts were asked to give suggestions on the instruments developed. The suggestions given by the material experts are as follows:

1. Questions use scalar concepts, so educationally should be consistent.
2. The data displayed must be rational if interpreted into a graph.

Suggestions from material experts are used to revise the essay questions, namely the questions about the material quantities and units, namely changing the units contained in the problem to be an international unit (SI)

Based on the results of the validation Practitioners for indicators there is a relationship between variables in each item the assessment is obtained with a very good category. Because the problem reflects the relationship between variables as an indicator of thinking deductive hypothesis. The indicator of the relationship between these variables indicates that items number 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 have excellent inter-variable relationship characteristics.

The next indicator is that it can be mapped using logic, which obtains ratings from experts with very good categories. HOTS-based description questions are indeed developed using simple sentences and can be digested by student logic. Therefore the question will be easily mapped by students who are answering it. These results indicate that all items can be mapped using logic as part of the indicator of deductive hypothesis thinking.

Then based on the results of expert validation for indicators can predict using the terms " if " " then " in each item, the assessment was obtained with a very good category. In each item HOTS questions that are developed always imply a causal relationship that can help students solve problems. Therefore these results reflect the presence of indicators that

can predict using the terms " if " " then " as an indicator of thinking deductive hypotheses. This indicates that all items have characteristics that can predict using the terms " if " " then ".

The last indicator, the theoretical provision, is the main condition in determining predictions, where the assessment is obtained from experts with very good categories. The results of this assessment show that at the beginning of the item about the description of HOTS, a little has been mentioned about the theory used in constructing the items. These results indicate that all items that have met the theoretical provisions are the main requirements for determining predictions as part of the indicator of thinking of a deductive hypothesis.

d. Small Group and Field Trials

Based on the small group trials that have been conducted, the average percentage of the overall aspects is 80.3%. From these results indicate that the instrument developed showed a very good category. From the results of the validation and trials, it shows that the items in the description are feasible to be implemented as a model of learning assessment in the field trials. Based on field trials that have been carried out, the average percentage of all aspects is 80.65%. This shows that the assessment model developed has a very good category.

From the results of validation and small group, trials show that the description items feasible to be implemented as a learning assessment model in field trials. Before being used as a learning assessment model, it was first revised in accordance with the advice of material experts, practitioners' experts in small group trials.

This result is in line with similar research conducted by Umi Pratiwi (2015), where the results of the trial of the product questions he did received a response with a very good category. Based on the analysis of the researcher, this is possible because the trend of developing the questions developed by Umi Pratiwi has been in the form of HOTS's description questions. Where students have begun to try questions that require high-level thinking (HOTS).

CONCLUSION

Based on the results of research and discussion, the conclusions are as follows:

1. Learning Assessment Model Based on HOTS on Straight Motion material developed from ten HOTS assessment items obtained seven items that have high validity based on expert science learning reviewers based on deductive characteristics that have indicators of relationships between variables can be mapped using logic can predict using provisions if / and the theoretical provisions are a condition for determining predictions and in terms of construction and language.
2. HOTS-based learning assessment model that is seven items tested validation by S3 students as practitioner validators. in science learning courses. The results of the reviewer obtained seven items but with minor revisions. based on deductive characteristics that have a relationship indicator between variables can be mapped using logic can predict using the provisions if / then and the theoretical provisions become a condition for determining predictions and in terms of construction and language.
3. The results of small trials obtained by the appraisal model can be used for PGSD undergraduate students with small revisions.
4. The results of a large group trial were obtained which were valid and reliability of 0.852. based on deductive characteristics that have an indicator of the relationship between variables can be mapped using logic can predict by using the provisions if / then. and the

theoretical provisions become a condition for determining predictions as well as in terms of construction and language.

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