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The Validity of Online Assessment Instruments for Measuring Higher Order Thinking Skills of High School Students in Physics Subject

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Abstract: Assessment instruments are assessment tools consisting of tests and non-tests which guide educators in making decisions and obtaining information on students' progress or achievement of competencies. A good assessment instrument has several requirements, including being valid and reliable. Currently there are no valid and reliable assessment instruments available that can measure students' higher order thinking skills, especially in high school physics subjects. This research aims to produce a valid and reliable instrument for measuring students' higher order thinking skills physics. The instrument of this research is questions to measure higher order thinking skills in the form of essay questions. Validity analysis is carried out by proving the validity of the content and criteria. The validity analysis results were 0.44 in the valid category and the reliability results were 0.70 in the high category. The research results show that the instrument has met the appropriate and valid criteria for measuring students' higher order thinking skills.

Keywords: Higher order thinking skills; Online assessment instruments; Validity

Introduction

Education is a dynamic process and always changes along with the development of era and technology. Education must be able to adapt to these developments in order to meet the needs of society and the world of work. Good education is education that is able to provide knowledge, skills, and attitudes that are relevant and up-to-date with societal needs and technological developments. In a broader context, education must also be able to develop students' abilities to think critically, creatively and innovatively, and be able to adapt to changes that occur in the future. The definition of education listed in Law no. 20 of 2003 concerning the National Education System states: "Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and good skills needed by himself, the community, the nation and the State. In this context, education is expected to create a conducive learning atmosphere and an effective learning process, so that students can be active and independent in developing their potential. The ultimate goal of education is to form a generation that has high character and skills, and is able to play an active role in building and developing the nation and state.

Education also aims to assist students in preparing themselves to face the demands and changes that occur in society and the world of work. Education plays a very important role in ensuring human survival and the development of a country. Therefore, various efforts are needed to improve the quality of graduates in achieving general educational goals. Regulation of The Minister of Education and Culture No. 23 of 2016 concerning educational assessment standards which are criteria regarding scope, objectives, benefits, principles,

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mechanisms, procedures, and instruments for assessing student learning outcomes which are used as the basis for assessing student learning outcomes in primary and secondary education.

In the learning process, an assessment is needed to determine the extent to which students understand the lesson. One of the subjects in school is physics. Physics is a natural science that studies the basic elements that make up the universe, the forces that work in it, and their consequences. In giving an assessment can give feedback to the teacher and also students. Even assessment can affect learning behavior because students tend to direct their learning towards assessment by educators. The quality of the assessment instrument influences the achievement of learning outcomes.

The demands of the 2013 curriculum in the education system require students to be active, creative, and innovative. In addition, the Ministry of Education and Culture through the Directorate General of Teachers and Education Personnel seeks to improve the quality of learning and improve the quality of graduates with programs developed in the form of developing learning oriented to higher-order thinking skills (Istiyono et al., 2020). In the establishment of a curriculum, planning is the first step. It entails assessing to determine the needs. Learners, teachers, community, and societal needs would all be considered as they relate to the curriculum. The learning outcomes are set after the needs have been identified. Teachers must develop strategies and methods to reach desired results. The support materials should also be written and include the means of evaluation (Rahmi et al., 2021).

This program was developed following the policy direction of the Ministry of Education and Culture which in 2018 has integrated strengthening character education and learning oriented to higher-order thinking skills. Instruments that can measure higher order thinking skills train students to think critically and solve problems as well as measure their performance by using the HOTS tool which includes three aspects in Bloom's taxonomy, namely analyzing, evaluating, and creating (Hidayatullah et al., 2022). Higher order thinking skills can be developed through the learning process and learning assessment (Widana, 2018). There are five skills related to HOTS: (1) critical thinking skills, (2) creative thinking skills, (3) problem solving skills, (4) decision making skills, and (5) argumentative skills (Prayitno et al., 2021). Indicators of higher order thinking skills are skills to analyze, evaluate, create, think critically, and think creatively. The quality of learning also needs to be measured by an assessment that is oriented towards higher order thinking skills.

Assessment plays a very important role in the learning process. Assessment assists teachers and students in evaluating student learning progress, as well as providing necessary feedback to improve the learning process. As learning managers, teachers are required to have the ability to compile and carry out assessments with the correct procedures (Brookhart, 2010). This is very important so that the learning objectives that have been set can be achieved properly (Trisnawaty et al., 2017). The assessment is carried out with the aim of knowing whether the student understands the lesson, and also improves the learning program. In general, teachers conduct classroom assessments related to teaching and learning activities in an effort to collect data, facts, and student learning documents that aim to improve learning programs Sani. The assessment is carried out in the learning process to determine the level of students' ability to understand the material that has been delivered. Assessment is an effort or action to determine the extent to which the goals set in the learning process have been achieved or not. The purpose of the assessment is to evaluate the progress of students, measure the achievement of learning outcomes, and determine whether the learning that has been carried out is effective or not (Sudjana, 2016).

The results of an accurate and objective assessment can motivate students to be even better. The process of implementing a good and correct assessment is very important in determining success in the learning process. One of the important things in the implementation of the assessment is the existence of adequate assessment instruments and in accordance with the learning objectives. Assessment instruments can be in the form of well-designed questions, both to test students' cognitive, affective, and psychomotor abilities. Assessment of cognitive aspects leads to an assessment of the knowledge possessed by students. The instrument used to assess cognitive ability is to use a test. A good instrument is an instrument that is valid, reliable, objective, practical and easy to implement (M. Yusuf, 2015).

Based on the results of the initial analysis that the assessment of learning outcomes, especially physics subjects at SMAN 1 Tanjung Jabung Barat, is carried out after the learning process at the end of each KD. In practice, the teacher applies higher-order thinking skills with cognitive levels C4-C6 on certain questions and in the form of sheet questions (Arif et al., 2020). Whereas higher order thinking skills can make students connect, manipulate, and transform their knowledge and experience to think critically and creatively (Arnellis et al., 2020). The use of Higher Order Thinking Skills (HOTS) in learning has many important benefits, one of which is that students' information or knowledge will be

stored longer than using only Lower Order Thinking Skills (LOTS). This is due to the fact that HOTS requires a deeper, critical, and reflective understanding, so that students need to think harder to solve problems and apply the concepts they have learned. Thus, the learning process becomes more significant and meaningful for students, so that the information or knowledge obtained will be easier to remember and use in real situations.

The instrument is a tool used in the process of collecting data or information (Saifudin, 2012). Instruments can be in the form of questionnaires, interviews, tests, or observations, which are used to collect the necessary data in accordance with research or evaluation purposes. Meanwhile, evaluation is an activity carried out to collect information about the performance or effectiveness of a program, policy, or activity. In the context of education, evaluation is usually carried out to measure student achievement in learning, as well as to evaluate the performance of teachers or the education system. Educational evaluation can be carried out using various types of instruments, such as tests, performance appraisals, or class observations. The instrument is a tool used to meet academic requirements in measuring an object. In the process of teaching and learning assessment instruments can't be separated.

The assessment instrument is an assessment tool consisting of tests and non-tests which guide educators to make decisions and obtain information on the progress or achievement of student competencies. A good assessment instrument has several requirements including being valid and reliable. Currently, there is no valid and reliable assessment instrument available that can measure students' higher-order thinking skills. In addition, the existing instruments do not meet the appropriate criteria, as well as the lack of components needed when making instruments. So that the research aims to develop assessment instruments that can be used to measure students' high-level thinking skills in class X physics online, which have good validity and reliability. The development of good assessment instruments will be very important in evaluating students' abilities in higher order thinking, because good instruments can provide an accurate picture of students' abilities in that regard. The good validity and reliability of the assessment instrument will ensure that the instrument can measure students' higher order thinking skills consistently and accurately.

Method

This type of research is research and development or R&D. R&D is a research method used to produce certain products, and test the effectiveness of these products (Arikunto, 2015a). R&D involves a series of structured and systematic activities to develop new products that are better and more useful. The R&D process starts with problem identification, then continues with designing solutions or products that are suitable to meet those needs. Next, the product is developed by making prototypes and conducting tests to ensure that the product works properly and is effective.

The development model used in this study is the ADDIE model. The ADDIE model consists of five stages, namely analysis, design, development, implementation, and evaluation. Each stage has different goals and tasks, and these stages are interrelated and influence one another. The analysis phase aims to understand the problems or learning needs to be solved. The design stage aims to design a curriculum or learning that fits the goals and meets learning needs. The development stage aims to develop learning media in accordance with the design plan. The implementation phase aims to implement or carry out the product that has been developed. The evaluation phase aims to evaluate the success of the product and determine further improvement or development actions.

The research instrument is a tool used to measure natural and social phenomena observed in research. These instruments can be in the form of questionnaires, tests, interviews, observations, or a combination of several other measurement tools. Data analysis techniques with regard to calculations to answer the formulation of the problem. Instrument data analysis techniques by experts using descriptive statistics. The weighting is done through a Likert scale. Analysis of instrument validity data by experts using the Aiken's V coefficient. The validity value uses the Aiken's V formula:

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

Based on the value of V obtained, then categorized as in Table 1.

Table 1. Product Validity Criteria

Interval	Criteria
≥ 0.6	Valid
< 0.6	Invalid

The data analysis technique of the test results of the instrument is divided into validity and reliability. Validity refers to the extent to which a measurement instrument is able to measure what it is supposed to measure, while reliability refers to the extent to which a measurement instrument can produce results that are

consistent and reliable. Both of these techniques are important for evaluating the quality of measurement instruments before they are used in research or evaluation. The method of testing the validity of the instrument trial uses product moment correlation by conducting. The validity of the description questions using the formula:

$$r_{xy} = \frac{N\sum XV - (\sum X)(\sum V)}{\sqrt{(N\sum X^2 - (\sum X)^2)\left(N\sum V^2\right) - (\sum V)^2)}} \quad (2)$$

The item is said to be valid if $r_h > r_t$, for the number of respondents 57 (n=57), the significance level of 5% based on the Product Moment correlation table is obtained $r_t = 0.26$. The item is said to be valid if the value of $r_{count} > r_{table}$ so that from the calculation of the formula above, it can be known whether the instrument is valid or not.

Reliability test aims to test the accuracy of the instrument in measuring what is being measured. Reliability test in research can be done using the Cronbach Alpha formula:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum s_i^2}{\sum s_t^2}\right) \quad (3)$$

The reliability criteria of this instrument are based on the following Table 2.

Table 2. Criteria for Instrument Reliability

Correlation Coefficient	Correlation
0.90 < r ≤ 1.00	Very High
0.70 < r ≤ 0.90	High
0.40 < r ≤ 0.70	Currently
0.20 < r ≤ 0.40	Low
r < 0.20	Very Low

Result and Discussion

Analyze

The analysis phase carried out was a needs analysis through an analysis of previous research and literature studies as well as gathering information related to the developed online assessment instrument. At this stage the researcher collected several references related to the development of test instruments with the characteristics of high-level thinking skills in students, namely in the form of theses, journals, articles, worksheets, and books. Then do some analysis, namely analysis of the curriculum used in schools, analysis of assessment instruments used in schools and material analysis. The results obtained at this stage are based on interviews conducted with physics teachers at school, it is known that the instruments used at school do not fully measure students' higher order thinking skills. The teacher takes the questions from the package book and the modules used. In addition, the questions given at school are not fully online in the form of reasoned multiple choice.

Design

After the initial analysis phase has been carried out, the next step is designing the assessment instrument. Designing a good assessment instrument involves several stages, including selecting interesting and contextual stimuli, making a good problem grid, making items that match the problem grid, and making answer keys. The problem grid must be well made and contain the concept or topic you want to measure. Then, the items are developed by considering the problem grid. Items must be relevant to the problem grid, according to students' abilities, and test higher-order thinking skills.

In addition, answer keys also need to be made to make it easier for the teacher to correct student answers. The answer key must be in accordance with the problem description and the items made. By designing a good assessment instrument, it is hoped that quality questions will be produced and be able to measure students' higher-order thinking skills (Susiatin, 2019). At this stage, the preparation of online media assessment and selection guidelines was also carried out.

Development

Expert validation is carried out by asking a number of experts in related fields to evaluate the assessment instruments that have been made. These experts can come from academics, practitioners, or experts in fields relevant to the instruments being made. Evaluation is carried out by looking at the suitability of the instrument with the learning objectives, suitability with the material being taught, validity of the content, ability of the instrument to measure the desired aspects, clarity of instructions, and ability of the instrument to distinguish between students who have different abilities.

After getting suggestions for improvement from experts, the next step is empirical validation. At this stage the assessment instrument was tested on a representative sample of students. The evaluation was carried out to see the performance of the assessment instrument, the compatibility between the items and the learning objectives, and the reliability of the instrument. The results of empirical validation can be used to improve the assessment instrument so that it is more valid and reliable.

Expert validation is seen from the results of material, construct, and language validation. Validation is carried out by 3 validators including 1 language validator, and 2 material validators. Based on the validation results that have been carried out, the results obtained are as in table 3.

Test validity is the test's ability to measure what it is supposed to measure. In the context of measurement, validity refers to the extent to which a test or measurement instrument can measure the desired construct or variable. If a test is not valid, then the measurement results from the test cannot be relied upon to measure certain constructs or variables. Therefore, it is important to validate the test before it is used in a real measurement situation (Hayashi et al., 2019). Based on the table it can be seen that the validity for the language aspect obtains a high validity value with an average validity value of 0.97. This is in accordance with the opinion Susilawati et al. (2023) that the use of language that is good and correct in questions is very important because it can affect the understanding and interpretation of the examinees of the questions given. In addition, the use of language that is in accordance with good Indonesian rules can also increase the credibility and quality of the exam itself. Therefore, it is important for question makers to pay attention to and ensure that the use of language is correct and in accordance with good Indonesian rules in each question prepared. The material aspect of the problem relates to the knowledge or knowledge tested in the question (Ariningrum, 2016).

Table 3. Validity Results

Aspect	Average Validity Value	Criteria
Technical	0.87	Valid
Theory	0.76	Valid
Construct	0.92	Valid
Language	0.97	Valid
Average	0.88	Valid

Each question must test the examinee's understanding of the material that has been studied or presented in the curriculum or learning. Therefore, the designer of the questions must ensure that the material being tested in the questions is in accordance with the applicable curriculum or learning. The construction aspect of the questions is very important to improve the quality of the questions and ensure that the questions prepared can test examinees effectively and efficiently (Kadir, 2015). Questions with good construction must meet several criteria, one of which is the formulation of clear subject matter and only contain the necessary statements (Arikunto, 2015b). This is important so that examinees can clearly understand what is meant by the questions and there is no ambiguity or confusion in answering the questions. In addition, the formulation of clear subject matter and only containing the necessary statements can also help increase efficiency in working on questions.

Empirical validity aims to determine the feasibility of the question, the instrument items can be said to have good empirical validity if the expected results are in accordance with experience. The item analysis data was obtained after the assessment instrument was tested on 57 students of class X MIPA 2 and X MIPA 4 at SMAN 1 Tanjung Jabung Barat with a total of 10 multiple choice questions with open-ended reasons. The results of the empirical validity of the higher order thinking ability assessment instrument obtained 8 valid items and 2 invalid items. With details average validity value of 0.44 with a valid category.

After the validity is obtained, the results then calculate the reliability value for the higher order thinking ability instrument. The reliability value for the reasoned answers was 0.70 in the high category. Instrument reliability is high if the reliability coefficient (r11) is 0.6 (r is lower than 0.8) (Mardhiyyah et al., 2016). The results of the research, the assessment instrument has fairly good reliability. In addition, the assessment instrument has also gone through a process of expert and empirical validation, so that it can be said to be valid for use in measuring students' high-level thinking skills in class X physics. This is in line with statement Sudiyatno (2010) to evaluate the effectiveness of learning assessment instruments, we can use several criteria such as validity, reliability, objectivity, systematization, economization, and practicality. The terms of a good instrument according to Yusuf (2015) are validity, reliability, objective, practical and norms.

Implementation

The implementation stage is the real stage for implementing the learning products that have been made. The implementation phase can also provide information about the effectiveness of the instrument in assisting teachers in evaluating students' higher-order thinking skills online. If there are obstacles or problems in the implementation stage, evaluation and improvement need to be carried out so that the instrument can be used optimally and gives the expected results.

Evaluation

The evaluation stage is the stage where the evaluation of the product being developed is carried out. Formative and summative evaluation. Formative evaluation is carried out at all stages including analysis, design, development, implementation aimed at revision needs. Meanwhile, a summative evaluation is carried out to assess the overall product being developed. In this study, it has the strength that in the preparation of the assessment instrument carried out it must meet the requirements of validity and reliability. In this study it can also be seen that in the multiple choice assessment instrument, the validity and reliability values are low

compared to the assessment with reasoned multiple choice questions to measure students' higher order thinking skills. The limitations of this study are that researchers conducted research up to the testing stage of the assessment instrument requirements on validity and reliability only.

The evaluation stage is a stage that aims to determine the quality of the developed instrument. At this stage the analysis of the test results of the instrument includes validity and reliability with the specified criteria. Revision of questions or improvement of questions that do not meet the criteria. If the questions that have been made have met the criteria and have represented the material being tested, then they are compiled into a test, but if they do not meet the criteria, improvements can be made to the questions that require improvement.

Conclusion

The conclusion of this study based on the results and discussion on the development of online assessment instruments measuring students' high-level thinking skills in physics subjects, it was found that the online assessment instruments tested valid and reliable. The validity of the developed online assessment instrument is based on the results of expert validation and empirical validation. Expert validation can be seen from the results of material, construct, and language validation. From the results of the study it can be seen that the assessment instrument measuring higher order thinking skills can use questions with answers to reasons because the validity and reliability values are higher.

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