Development Using Higher Order Thinking Skills Assisted by Quizizz Applications in Science Learning

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Abstract. The purpose of this study is to develop a valid, reliable, feasible, and practical test instrument based on Higher Order Thinking Skill (HOTS) for grade V elementary school science learning theme 8 The environment of our friends. This research technique combines R&D with an ADDIE research design (analysis, design, development, implementation, and evaluation). Design, expert validation, small-scale trials, and large-scale trials are all steps developed. The instrument created is a multiple-choice instrument that makes use of the Quizizz application. The data collection technique used in this development research is a multiple-choice test and a questionnaire on practicality. The results of the validation of the HOTS-based multiple-choice test instrument are valid. The reliability coefficient for the limited-scale trial was 0.648, while the reliability coefficient for the large-scale trial was 0.762, indicating that the instrument is reliable. A practicality questionnaire was developed with four raters who demonstrated very practical requirements.

Keywords: development of test instruments; hots, science learning

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INTRODUCTION

The development of the instrument is an attempt to achieve a higher quality educational process through the use of a measuring instrument in the form of a good test instrument to obtain more precise information about the cognitive abilities of students, particularly in the dimension of thinking ability. Cognitive instruments that result from instrument development research can be subjected to research and development (*R&D*) procedures (Adib, 2015). The importance of developing instruments is the first step toward determining the extent to which students are stable in their problem-solving abilities, so that teachers can map students' abilities and design learning programs that are appropriate for their circumstances. Mardhiyyah *et al*., (2016) state that student development through education begins with the exploration of fundamental potentials that are geared toward comprehending, appreciating, and applying.

Minister of Education and Culture Regulation No. 21 of 2016 on content standards explains that 6 aspects of skills must be developed in the 2013 curriculum. It includes creatively, productively, critically, independently, collaboratively, and communicatively. This ability conveys Indonesia's educational vision, which states that students must acquire various abilities, including identifying, evaluating, and solving problems creatively using higher-order thinking skills (HOTS). According to Fajriyah & Agustini (2018), knowledge is essential for developing quality humans in the twenty-first century, including the ability to collaborate and think critically. Çimer *et al*. (2013) also stated that teaching requires a change in instructional paradigms by ensuring that HOTS are taught and assessed using the appropriate instruments. Desi Fitriani, *et al*. (2018) in a graduate characteristic, students can think at higher levels with better expectations. According to Lewy *et al*. (2009) higher-order thinking is the basis of Bloom's Taxonomy thinking. This thinking requires a process of cognition more than any other and has a more general benefit. Therefore Heong et al., (2011) explain higher-order thinking skills, that "high-order thinking skills will require someone to apply new information or previous knowledge and manipulate information to reach possible answers in new situations." Lewy *et al.*, (2009) stated that higher-order thinking skills could analyze, evaluate, and create. This analytical ability relates to contrasting what is known, analyzing arguments, and comparing and identifying the main idea of the question. The ability to evaluate is closely related to providing solutions and methods. It is demonstrated through the provision of an assessment when responding to questions and critiquing arguments. Creative ability is related to designing or planning a way to work on the problem and the steps for doing it (Kurniati *et al*., 2016).

The implementation of the HOTS-based test instrument is the main assessment in current learning, however since the covid-19 or coronavirus disease that attacked humanity and became a global pandemic outbreak. The Covid-19 virus has caused paralysis in the education sector (Wahyono *et al*., 2020). Initially, well-organized teaching and learning activities became increasingly hindered. All activities associated with getting together began to be phased out, and public spaces, including schools, were closed. Until the government is forced to implement a study from home (SFH) policy or requires students to study from home as a preventive measure against the spread of the COVID-19 virus (Rigianti, 2020). This situation obligates educational institutions to adopt online learning systems (Rusmiati *et al*., 2020). By the circular issued by the Ministry of Education and Culture (Kemendikbud) Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period for the Spread of Covid-19 (Dewi, 2020) and Circular No. 15 of 2020 concerning Guidelines for Organizing Learning from Home in an Emergency Period for the Spread of Corona Virus Disease (Andini & Widayanti, 2020), which in the circular states that teaching and learning activities are carried out from home through online or online learning.

The "Quizizz" application is one such application that can be used as an evaluation medium. “Quizizz” is used to create interactive test games that can be used to assess student learning outcomes. It also serves as a platform accessible for free via applications or the web (Agustina & Rusmana, 2019). Minister of Education and Culture Regulation No. 21 of 2016 on content standards explains that 6 aspects of skills must be developed in the 2013 curriculum. It includes creatively, productively, critically, independently, collaboratively, and communicatively. This ability is a means of implementing the vision of Indonesian education, which requires students to acquire various abilities, including the capacity to think critically and creatively to solve problems using higher-order thinking skills (HOTS). According to (Fajriyah & Agustini, 2018) knowledge is required to develop quality humans in the twenty-first century, including the ability to collaborate and think at a high level (critical and creative thinking). According to (Fitriani *et al*., 2018) a graduate characteristic is the ability of students to think at a higher level with higher expectations.

According to Lewy *et al*., (2009) Bloom's Taxonomy thinking is based on higher-order thinking. More than any other, this type of thinking requires a cognitive process and has a broader benefit. Additionally (Yuniar *et al*., 2015) stated that the questions based on higher-order thinking skills assessed aspects of analysis, evaluation, and creation, rather than just memory or memorization. Critical thinking abilities were assessed at a higher level. Sukla & Dungsungneon, (2016) explain higher-order thinking skills by stating that they require someone to apply new information or possible solutions in novel situations. According to Luthvitasari *et al*., (2012) developing critical thinking skills is caused by its influence on people's ability to follow science and technology, which are currently advancing at a breakneck pace.

Higher-order thinking abilities refer to the capacity to connect, manipulate, and transform previously acquired knowledge and experience to think critically and creatively to make decisions (Rofiah *et al*., 2013). According to Heong *et al*. (2011) higher-order thinking skills are crucial in teaching and learning. Critical thinking abilities are important in the educational process. The way one thinks can affect one's ability to learn and the speed and effectiveness with which one learns. As a result, thinking abilities are inextricably linked to students' learning process to think to affect their educators' development positively. The results of researchers' observations in six schools demonstrated that fifth-grade students' science learning outcomes were classified as less than optimal. Less than optimal science learning outcomes are evident in Table 1 for the acquisition of mid-semester 2 test scores on 2020/2021 academic year themes 6 & 7.

Table 1. The observations from the study's initial assessment

Elementary School Name	Academic Year 2020/2021 (Even semester)		
	Total Student	∑ students below KKM (%)	(%)
Pasirhhhuni Elementary School	71	41	42
Legok II Elementary School	18	11	39
Tunjungseto Elementary School	29	11	42
Cimanggung IV Elementary School	35	19	46
Al-Hudab Elementary School	26	18	31
Al-Masoem Private Elementary School	25	14	52

According to Table 1, the percentage of students with mid-semester 2 test scores remains below the minimal criteria for completeness (KKM). Pasirhuni Elementary School achieved only 42% of 71 students' learning outcomes, Legok II Elementary School achieved 39% of 18 students, Tanjungseto Elementary School achieved 42% of 29 students, Cimanggung IV Elementary School achieved 46% of 35 students, Al-Huda Elementary School achieved 31% of 26 students, and Al-Masoem Private Elementary School achieved 52% of 25 students. The researchers conducted an investigation using these data to determine the HOTS-based test instruments used in schools in Sumedang Regency, West Java, specifically Legok II Elementary School and Pasirhuni Elementary School. Elementary School was chosen as a training site for creating HOTS questions in each cluster in 2018. As a result, the researchers focused their research on developing HOTS-based test instruments in these two schools.

Based on the information about higher-order thinking skills, it is necessary to create a test instrument based on High Order Thinking Skills. In addition to developing the curriculum, all teachers are expected to ask HOTS questions when assessing learning outcomes. The HOTS form questions are designed to assess higher-order thinking skills. From the perspective of Bloom's taxonomy (revision) or cognitive processes, the cognitive domain of HOTS questions is C4, C5, and C6. In addition to the cases described previously, it turns out that the instrument's item analysis via the Iteman program used by teachers at Pasirhuni Elementary School revealed that it was 70% unfit for use. According to information about higher-order thinking skills, there is a need to develop a test instrument based on these skills. Along with the curriculum development, all teachers who conduct an assessment of learning outcomes are expected to create HOTS questions. HOTS questions are designed to assess higher-order thinking skills. If the cognitive domain of HOTS questions is viewed through the lens of Bloom's taxonomy (revision) or cognitive processes, it is C4, C5, and C6.

HOTS questions in the assessment of learning outcomes can help students hone their abilities and skills following the requirements of 21st-century competencies. Looking at the characteristics of fifth-grade students who are 10-11 years old on average enter the final stage of concrete operations, the ability to think logically and systematically, solve problems, formulate strategies, connect concrete objects, clarify, and draw conclusions is evident. Sunarsih *et al*., (2015) provide direct experience to students to develop their competencies so that they can scientifically explore and understand nature. In this case, the HOTS question should be used in elementary schools, particularly for fifth-grade students. According to Brookhart's explanation (Wulandari *et al*., 2020) the solution is to use higher-order thinking skills to increase learning motivation, quality education and face 21st-century skills because these questions will help students become good. This research aims to develop a HOTS-based test instrument that is reliable, feasible, and usable. Furthermore, the benefits for the institution include contributing to the improvement of test instruments and serving as a reference for educators in developing and creating HOTS-based test instruments in science learning for class V Elementary School.

METHODS

The study was carried out at Legok II Elementary School and Pasihuni Elementary School in Sumedang, West Java. This research employs the research and development (R&D) method, as well as the ADDIE research design (Analysis, Design, Development,

Implementation, and Evaluation) developed by Dick and Carey (Aldoobie, 2015).

1. Analysis

Needs analysis is performed to identify potential and problems that result in gaps between reality and expectations. This stage was carried out in several fields, including students, teachers, and test instruments. During the analysis phase, it was discovered that several problems, as well as potential, existed at Legok II Elementary School and Pasirhuni Sumedang Elementary School. The findings indicate that working on HOTS-based questions is a problem in the school because students are not used to working on questions relating to their ability to analyze, evaluate, and create.

2. Design

The HOTS-based test instrument was designed based on an assessment of the questions used by the teachers at Legok II Elementary School and Pasirhuni Sumedang Elementary School to overcome the weaknesses identified in the questions used. The questions used by teachers in daily tests have not been linked to the HOTS questions, and the questions created by teachers are not appropriate in their use of grammar, resulting in double meanings for students. The next step is to use the Quizizz application to create a HOTS-based test instrument for science learning for class V on theme material 8 of our best friend's environment.

The researcher chose the theme because the theme presented was identical to the daily life of students. The theme taken is the water cycle. This material is very appropriate for developing students' critical and creative thinking skills, such as maintaining water availability, saving water, protecting forests, process rain, and so on. The results of this stage of research are:

a. Syllabus
b. HOTS-based test instrument
c. Composing into the quizizz application
d. Key and discussion

3. Development

In the development stage, an assessment of the product design of the HOTS-based test instrument is carried out by asking competent experts to make corrections to the product design. According to (Samsul Amaril et al., 2014) relevant test instrument products were validated using 3 experts, namely material, language, and evaluation experts in their fields. Furthermore, it is calculated and described using Aiken'V validation.

4. Implementasion

Implementation is a real step to implement the product, namely the HOTS-based test instrument. This product stage has been made according to its role or function so that it can be implemented. Implementation is done through a limited scale and wide scale. It was done to obtain data related to data analysis on the practice of using HOTS-based test instruments. The teacher is asked to provide comments as a second revision according to the responses given. After distributing the questionnaire, the researcher conducted data analysis. The first analysis was carried out based on the results of the response questionnaire. This analysis was conducted to determine the practical value of the developed HOTS-based test instrument.

5. Evaluation

Evaluation is to see whether the test instrument product being developed is in line with initial expectations or not. The evaluation stage is carried out during the development and implementation stages. The evaluation results are used as feedback to make improvements. The evaluation stage in this study was carried out until the formative evaluation aimed at the need for revision. The validity of the data in this study stated that there were two kinds of tests: the validity test, which is a technique to measure the reliability of the data examined through the completeness of data from various sources. Second, the research dependence test (dependability) is also called the reliability test, which represents a series of data search activities that are traced. Before taking data, the instrument's validity was carried out, namely by consulting with experts in the field of developing test instruments. The instrument that was consulted was in the form of a test instrument validation sheet based on high order thinking skills (HOTS).

The development stage of the test instrument starts from expert validation, namely language experts, material experts, construction experts, practitioner 1 and practitioner 2. Then the instrument quality test is carried out by testing the validity of the questions. According to all experts, instruments that were declared valid were tested on a limited scale with 16 students of class V Legok II Elementary School, Sumedang, West Java. The results of the limited-scale trial were revised and continued in a large-scale trial with 64 students of class V at Pasirhuni Elementary School, Sumedang, West Java.

Qualitative data processing is carried out to

meet the requirements that the test must accurately measure what competencies it wants to measure. Expert reviewers conduct a validity check following their field. Its purpose is to determine whether the test items are properly fit for use. Quantitative data processing is carried out using instrument item analysis, reliability, difficulty level, and discriminatory power. The instrument's practicality is demonstrated by the instrument's response rate of more than 71% to the teacher response questionnaire.

RESULTS AND DISCUSSION

This HOTS-based test instrument is validated through several tests, including validity, feasibility, and practicality.

Validity test

The purpose of content validation, frequently referred to as content validity, is to minimize instrument-related errors during the early stages of development before field testing (Shrotryia & Dhanda, 2019). Content validity aims to ascertain the most important aspects (Sjoberg *et al*., 2018). The data for the content validity tests were gathered through the completion of questionnaires on construction, material, language, and practitioner validity and interviews with practitioners 2. Five validators completed the questionnaire, three of whom were expert lecturers, and two were teachers at each of the schools studied. The content validity test is calculated using the Aiken'V formula, and the results are then confirmed using Aiken's table. If Vcount V is greater than zero, the instrument table is said to be valid and testable. For expert validation, the researcher used a questionnaire sheet comprised of five expert judgments. The rating scale uses a scale of 1 to 5, so the acceptance coefficient of validity is adjusted to the Aiken'V table, which is 0.80. Validation results were described as satisfactory, with a validity category ranging from moderate to excellent. In Table 2 is the calculation of the validity results using the Aiken'V formula as follows.

Table 2. Validator Assessment Results

Question item number	Aiken's V. Index	Criteria
13,19,21	1	Valid
3,4,5,9,12,18,22,24,27,28	0.95	Valid
6,8,10,14,17,20,29	0.90	Valid
1,2,7,15,16,26	0.85	Valid
11,23,25,30	0.80	Valid

The data in Table 2 can be used to determine the items' level of validity using the Aiken'V formula. With an Aiken'V index greater than 0.80, the number of 30 items is seen to be valid. Items 13, 19, and 21 have an Aiken'V index of 1, items 3,4,5,9,12,18,22,24,27, and 28 have an Aiken'V index of 0.95, items 6,8,10,14,17,20, and 29 have an Aiken'V index of 0.90, items 1,2,7,15,16, and 26 have an Aiken'V index of 0.85, and question 11 has an Aiken'V index of 0.80. After validating and revising the HOTS-based test instrument with expert input, it is applied to a limited-scale and a large-scale trial. The limited and large scale trials collected data on the cognitive learning outcomes of the HOTS-based test instrument. The HOTS-based test instrument is a multiple-choice question with one correct answer and one distractor to assess broad knowledge with varying domain levels, with item analysis used to develop this multiple-choice test. Quantitative and qualitative questions.

The qualitative analysis takes the form of a study that examines a problem from a material, construction, language, and practitioner perspective. It means that the 30 multiple-choice test questions met the criteria for qualitative analysis after being judged by five experts (lecturers and teachers of class V). The quality criteria for the HOTS questions developed in her research (Wulandari *et al.*, 2020) state that the questions are valid if at least four of the five validators state that the HOTS questions are consistent with the theoretical foundation and with one another. It is demonstrated that the average value of construction validation and the materials, language and practitioners are all included in the valid criteria.

Test of feasibility

The feasibility test is used to determine the validity of HOTS-based item analysis results. This feasibility test makes use of HOTS IPA questions on the theme 8 Friends of Our Environment in class V. There are a total of 30 questions in this test. The item analysis yields information about the questions' reliability, discriminating power, and level of difficulty. Data from two schools' feasibility tests, Legok II Elementary School and Pasirhuni Elementary School.

Reliability

The test instrument is reliable because it is multiple choice with questions requiring higher-order thinking skills. It was developed using

Cronbach's alpha formula and the SPSS 16 program. The SPSS Reliability Test Output includes the instrument's reliability test on a limited scale and the area of the reliability coefficient estimate. The results of the reliability testing analysis using data from small- and large-scale trials are summarized in Table 3 as follows:

Table 3. Results of Reliability test

Test	Cronbach's Alfa	N of Item	Category
Limited Scale	0.648	30	High
Large Scale	0.762	30	High

Table 3 demonstrates that the limited-scale test reliability coefficient is 0.648 or greater than Rtable, which is 0.296, implying that the multiple-choice test instrument is reliable. The large-scale results show that the reliability coefficient is 0.762, which is greater than Rtable's 0.296, implying that the multiple-choice test instrument based on higher-order thinking skills is tested reliably. According to (Zulyusri; Sumarmin, 2017), a test is reliable if it can give a consistent result when repeated often or if the test shows determination. After extensive testing, quantitative analysis was performed and proven by construct validation, namely SPSS 16, on 30 HOTS-based multiple-choice test instruments classified as good questions on a limited scale.

The results show that the 30 items are classified as high-quality or good questions. A large-scale quantitative analysis revealed that the 30 items have a high-reliability coefficient value, a good difficulty rating, and good discriminating power. According to Hanifah, (2014) a good question has a difficulty level ranging from 0.30 to 0.70, a discriminatory power greater than 0.30, and a reliability value greater than 0.6. As a result, the 30 items on a large scale met the requirements for a proper question based on quantitative analysis. According to Herawati *et al*. (2014) relevant research on HOTS-based instruments, the development of HOTS assessment learning tools overcame students' understanding of concepts and to be careful in analyzing test instruments. As a result, a product was created based on the existing problem, namely developing a HOTS test instrument. Following trials 1 and 2, the results demonstrated that the HOTS assessment product was valid, practical, and usable.

Yuniar *et al*. (2015) also developed HOTS-based test questions to describe the use of HOTS on class V objective test questions at Elementary School 7 Ciamis. The reason for conducting this research is that the teacher continues to ask questions that do not qualify for good questions. Based on the analysis results, 14 items qualify as valid, practical, and feasible for developing HOTS questions, and 6 items do not qualify for developing HOTS questions. Lestari *et al*. (2016), Bloom's proposed HOTS-based test questions beginning with C4 (analyzing), C5 (evaluating), and C6 (creating) (creating). The findings of this HOTS study are presented in the form of HOTS-based test questions in grade IV with the theme "always saving energy" and various sub-themes on energy sources. The test consists of 23 questions, 10 of which are multiple-choice and 13 of which are essay questions.

According to the findings of student analysis, while working on test instruments, science learning is more about measuring students' abilities at the level of questions based on LOTS (lower-order thinking skills), demonstrating the process for memorizing and remembering. Students are not used to solving HOTS-based questions or problems in science learning, which is one contributing factor. In general, the findings of this study are supported by research (Herawati *et al*., 2014) which explains that in order to overcome this, one must design a product based on the existing problems, specifically developing a HOTS test instrument. Following testing, the product is disseminated by completing a final revision to create a HOTS assessment that can be used in the form of multiple-choice questions and HOTS assessment description questions.

Practical Examination

The practicality of the HOTS-based assessment instrument is a measure of how easy the assessment instrument is to use and does not impose an additional burden on students a (Sumaryatum *et al*., 2016). The fifth-grade teacher's responses as a practitioner of the developed instrument were used to determine the instrument's practicability. Before the teacher completes the practicality questionnaire, she can discuss the appropriate score to be assigned to the developed instrument. The calculation of practicality results using the following practicality formula is shown in Table 4

Table 4. Practicality Assessment Results

Rater	1	2	3	4
Total Score	41	41	40	39
Percentage	93.1	93.1	90.9	88.6

Based on Table 4 shows the results of the Practicality Questionnaire Recapitulation by the Rater. The criteria are very practical, based on four raters using a Likert scale of 1 to 4. Proves that the researcher provides guidelines on practicality criteria when classifying or deciding on a test instrument based on higher-order thinking skills that are developed practically or not. Table 5 provides a more specific scoring guideline

Table 5. Percentage of Practicality Criteria

Percentage	Category
86 - 100	Very practical
71 - 85	Practical
56 - 70	Sufficiently practical
41 - 55	Less practical
≤25 - 40	Not practical

Table 5 describes the qualitative analysis conducted to determine the feasibility of using a questionnaire for multiple-choice questions. The questionnaire sheet was given to four teachers in class V at both schools, Legok II Elementary School and Pasirhuni Elementary School. The results from filling out the questionnaire were obtained from the teacher's assessment, namely 93.1%, 90.9%, and 88.6%. As a result, the test instrument based on higher-order thinking skills in science learning for grade V elementary schools is found in very practical criteria. The practicality percentage criteria stated to be very practical range from 86% to 100%. According to (Phito *et al*., 2019) values greater than 85% fall into the very practical category. It means that the 30 HOTS-based multiple-choice test questions met the requirements for qualitative analysis.

CONCLUSION

The research on the test instrument based on higher-order thinking skills aided by the Quizizz application in the science learning theme 8 of our friend's environment in grade V elementary school is that the HOTS-based test instrument qualifies of being valid, reliable, feasible, and practical.

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