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High-Level Thinking Test on Science Material for Fifth Grade Elementary School Students

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Abstrak

Kemampuan siswa dalam berpikir tingkat tinggi yang masih kurang banyak dipengaruhi oleh kualitas instrumen yang kurang menerapkan kemampuan berpikir tingkat tinggi. Penelitian ini bertujuan untuk menciptakan tes berpikir tingkat tinggi IPA untuk siswa kelas V Sekolah Dasar. Instrumen yang dikembangkan berbentuk tes uraian terdiri dari 20 butir soal materi Gaya. Penelitian ini merupakan penelitian R&D dengan model Formative Research. *Teknik analisis data menggunakan analisis kuantitatif dan statistik infrensial. Subjek penelitian yaitu para ahli dan praktisi, guru dan siswa sekolah dasar. Hasil penelitian diperoleh prototipe tes berpikir tingkat tinggi IPA terdiri dari 1 paket materi IPA bentuk uraian. Validitas tes memperoleh hasil 17 item valid. Seluruh soal yang valid adalah* reliable. *Indeks daya beda tes diperoleh 3 butir soal berkategori sedang, 14 soal berkategori tinggi. Indeks kesukaran butir tes berkategori sedang. Tingkat ketepatan parameter tes diperoleh 10 soal berkategori fit dan 7 soal berkategori tidak fit serta diperoleh nilai logit yang tinggi menunjukkan kemampuan siswa menyelesaikan soal yang tinggi. Simpulan penelitian yaitu instrumen yang dikembangkan dapat mengukur kemampuan berpikir tingkat tinggi siswa dan dapat digunakan dalam proses pembelajaran. Implikasi penelitian ini yaitu soal yang telah dikembangkan bisa dimanfaatkan guru untuk mengukur efektifitas pembelajaran sesuai kebutuhan siswa.*

Kata Kunci: *Instrumen Tes, IPA, Kemampuan Berpikir Tingkat Tinggi*

Abstract

The quality of the instrument that does not apply high-level thinking skills greatly influences students' ability in high-level thinking, which is still lacking. This study aims to create a high-level thinking test in science for grade V elementary school students. The instrument developed is in the form of a descriptive test consisting of 20 questions on Style material. This study is an R&D study with a Formative Research model. The data analysis technique uses quantitative analysis and inferential statistics. The study subjects were experts and practitioners, teachers and elementary school students. The study results obtained a prototype of a high-level thinking test in science consisting of 1 package of science material in a description. The validity of the test obtained 17 valid items. All valid questions are reliable. The test discrimination index obtained 3 questions in the medium category and 14 in the high category. The test item difficulty index is in the medium category. The test parameters' accuracy level obtained 10 questions in the fit category and 7 in the unfit category. A high logit value indicated students' ability to solve questions. The study concludes that the instrument developed can measure students' high-level thinking skills and be used in the learning process. This research implies that the questions that have been developed can be used by teachers to measure the effectiveness of learning according to student needs.

Keywords: Development, Test Instrument, High-Order Thinking Abilities

1. INTRODUCTION

Education can be interpreted as a process to obtain, develop knowledge, skills, and attitudes in the process of teaching and learning activities. Education can be said to be one of the important foundations for the progress of the Indonesian nation. Through education, it can influence someone to adapt to their environment in community life and can also improve the quality of human resources (Jufriadi et al., 2022; Pratama et al., 2020). Education has a very

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important role in ensuring a person's survival, because education is a means to develop and improve the quality of human resources, with education human life is directed (Putri & Gumala, 2020; Tang et al., 2020). With the improvement in the quality of education in Indonesia, it will direct students to achieve the demands of the 21st century in the world of education. Students who live in the 21st century must master the 4C skills, namely critical thinking, communication, collaboration, and creativity (Sukmawati & Ghofur, 2023; Wardani & Budiadnyana, 2023). Students who master the 4C skills will find it easier to solve problems in everyday life. High-level thinking is very important to develop in order to have high competitiveness so that they can compete in global competition and make it easier for students to learn with discovery (Fuldiaratman & Ekaputra, 2023; Purwasih et al., 2021).

The curriculum is a set of subjects and educational programs provided by an educational institution which contains lesson plans to be given to students in one period of education (Magdalena et al., 2020; Pratycia et al., 2023). The curriculum currently used in Indonesia is the 2013 curriculum. The learning process in the 2013 curriculum is implemented to develop students' potential to be more advanced in knowledge, attitudes, and skills that can be used in the community environment. The approach used in the 2013 curriculum is by using a scientific approach. The scientific approach is a learning process that is designed in such a way that the aim is for students to actively construct concepts, laws, and principles through stages (Dahliana et al., 2019; Mustika et al., 2021). Assessment of student learning outcomes in the 2013 curriculum places more emphasis on high-level thinking skills (High Order Thinking Skill / HOTS) (Niswara et al., 2019; Rezkillah, 2020). The learning process in the 2013 curriculum requires students to be more active and educators are expected to provide problem-solving activities to foster students' high-level thinking skills (Umami et al., 2021; Wirdayanti et al., 2023). High-level thinking is an activity that involves thinking about ideas or concepts related to the given concept or problem (Puspitasari et al., 2020). The development of students' high-level thinking can be done in every learning content, one of which is the science learning content. Science lessons have an important role as a form of preparing students to face everyday life. Natural science or IPA is a science that studies nature and various phenomena found in this universe. With the existence of science lessons, it is hoped that students can develop the ability to analyze, think logically, make conclusions based on data or facts in the field, and train students to think at a high level (Agnafia, 2019).

However, students' high-level thinking skills in Indonesia are relatively low based on the results of PISA in 2018. The results of the Programme for International Student Assessment (PISA) data in 2018 quoted from the Organisation for Economic Co-operation and Development which evaluated the education system in Indonesia in 2018 ranked 72 out of 77 countries. Indonesia obtained a science score of 379, while the average score of other PISA was 487 (Pratiwi, 2019). This shows that the ability of Indonesian students in answering questions that refer to high-level, logical, and problem-solving thinking skills is still in the low category. Students' high-level thinking skills must be improved from elementary school so that at the next level of education students are accustomed to solving a problem. High-level thinking can be measured using an essay test. High-level thinking tests are very important so that students have the ability to analyze a problem (Kurnia et al., 2022; Saraswati & Agustika, 2020). This is able to make students develop and apply the ideas they have. In addition, students can also be more careful in sorting the credibility of a source, expressing opinions and finding solutions to solving problems faced in everyday life (Firdaus et al., 2019).

In reality, students' abilities have not been developed optimally, especially with the presence of Covid-19 (pandemic) which has a major impact on inhibiting the students' learning process, where they are not yet competent in solving problems independently

(Ahmadi et al., 2021). Students' high-level thinking skills are still low, as evidenced by facts in the field, namely the results of interviews with grade V teachers and observations of grade V students at SD N 2 Sading, SD N 3 Sading, and SD N 4 Sading as well as the results of the education quality report. Based on the results of interviews and observations carried out at SD N 2 Sading and SD N 3 Sading on Monday, September 24, 2022 and SD N 4 Sading on Wednesday, September 26, 2022, it was found that students' high-level thinking skills during learning activities were still low. From the results of interviews with teachers, it was stated that during learning activities only a number of students were able to think at a high level, which was indicated by the lack of student activity in asking questions, developing an idea, expressing an opinion, analyzing, solving a problem, and making conclusions. Based on the results of observations, it was found that students were not focused on learning, low interest in student participation in learning, less conducive classroom conditions, teachers only conveyed material based on books without using learning media, lack of experimental activities, observations, analyzing and investigations. This causes a lack of improving students' high-level thinking. High-level thinking must be developed optimally since elementary education to prepare students for higher levels of education, prepare the golden generation of 2045, prepare critical and creative human resources according to the hopes of the 21st century era (Firdaus et al., 2022; Rofiq et al., 2019). Students' low high-level thinking skills will have a negative impact or can hinder them from continuing to higher education. Existing problems if not followed up will have a negative impact on the education process.

The solution to overcome this problem is to develop an assessment instrument. An assessment instrument is a means of assessment or evaluation that is used to collect data and information (Kurniati & Wiyani, 2022). Teachers should prepare assessments according to the teacher's pedagogical competence. However, there is an imbalance in this regard, namely that teachers' knowledge of assessment is still very low. Lack of problem-solving activities in learning that do not emphasize students' high-level thinking skills. The learning process is not in line with the 21st century and the 2013 curriculum, students must have critical thinking (Fransiska et al., 2021; Puspitasari et al., 2020). A good test instrument is a tool that meets the criteria of substance, constructiveness, language and has a good level of validity and reliability (Tanjung & Muliyani, 2021). A test that is said to be valid means that the validator agrees that the test instrument is suitable for use. The reliability of an assessment tool is interpreted as the consistency (Jannah & Khairuna, 2022). The instrument to be used should be analyzed before implementing it. The instrument is a data collection tool, so the instrument must be made optimally and can obtain data based on the needs of the research. One of them is through improving the quality of the assessment instruments used. Efforts that can be implemented are by creating assessment instruments that focus on students' HOTS. The development of this high-level thinking test refers to HOTS-based questions, including analyzing (C4), evaluating (C5), and creating (C6)(Afrita & Darussyamsu, 2020). The development of HOT-oriented tests is aimed at compiling quality instruments (valid and reliable), so that this test can be used to assess the extent of students' critical reasoning skills during classroom learning activities, especially in the field of science.

The research that is in line with this research is the development of instruments.high-level thinking skills in science for grade IV elementary school students that produce valid and reliable critical reasoning skills instruments (Jaya et al., 2020). The next research is to develop a high-level thinking ability test instrument in junior high school science which obtains valid and reliable instrument results to be used as a high-level thinking instrument (Jamaluddin et al., 2020).So far, there have been several studies on the development of high-level thinking instruments, but there are differences in the development of instruments that researchers have conducted with other studies, namely in the indicators of high-level thinking

skills. The characteristics of the science high-level thinking test that are compiled, namely the science high-level thinking test uses the Ennis indicator in the context of science, this high-level thinking test is developed from the 2013 curriculum with heat and its transfer material, and the test form is an essay test. The difficulties experienced in the high-level thinking test, namely students must develop their own ideas to answer an essay question where the teacher does not provide a choice of answers, does not answer briefly but writes the reasons why this can happen, and does not carelessly use the bibliography used to add information. High-level thinking ability instruments, especially in the Physics subject matter for high school students (Desiriah & Setyarsih, 2021). High-level thinking skills instrument with the help of Quizizz on Thermochemistry material for grade XI high school students (Kurnia et al., 2022). Because there has been no difference in development carried out in previous studies, and no one has developed a high-level thinking ability instrument for elementary school students, so that it becomes a novelty of this study. The importance of developing high-level thinking skills that can be realized by using instruments to measure students' high-level abilities. The purpose of the study is to create a high-level science thinking test for grade V elementary school students.

2. METHOD

The design in this study is a type of research and development or Research and Development (R&D). The research model used in developing this instrument is a formative research type development model which includes a preliminary stage, a self-evaluation stage, a formative evaluation stage which goes through expert reviews and field tests (Wirdayanti et al., 2023). At the Preliminary stage, a review of several reference sources related to this study was conducted to obtain information about the tools or media that are generally used to measure students' mathematical disposition abilities. At the self-evaluation stage, a self-assessment was carried out on the design of the high-level thinking ability test instrument which includes student analysis activities, curriculum analysis, and analysis of devices or materials to be developed; activities to design instrument question grids, instrument questions and answer keys for high-level thinking ability instruments. At the expert review stage, namely a technique for obtaining input or suggestions from experts to improve the test instrument. At the expert review stage here or usually called a validity test, the product that has been designed will be examined, assessed and evaluated by experts. At the field test stage, it is carried out to test the feasibility of the instrument in improving high-level thinking abilities.

The subjects of the study were experts and practitioners, teachers and elementary school students. The objects of this study were the feasibility of high-level thinking ability instruments (validity and reliability) and effectiveness. Data collection methods used questionnaires and tests. The questionnaire method was used to collect expert scores and the test method was used to collect data on students' high-level thinking abilities. The data collection instrument used a descriptive test. Data analysis techniques were quantitative analysis and inferential statistics. The instrument was tested by experts to determine its validity using Gregory. The feasibility of the field-tested instrument included internal consistency tests, test reliability, discrimination index, item difficulty index, HOTS data analysis using inferential statistical analysis.

3. RESULT AND DISCUSSION

Result

In the study, the results of the test instrument have been developed by following the steps that have been described in several stages. First, the Preliminary stage is carried out by determining the place and subject of the trial by contacting the principal and science subject teachers at the school that will be used as the trial location. In addition, based on the results of the curriculum analysis, the indicators of learning materials compiled in the high-level thinking ability instrument are listed in Table 1, and Table 2.

Table 1. The Science Material Instrument Indicators

Learning Objectives Flow	Indicator
3.3 Identifying various types of force, including: muscle force, electrical force, magnetic force, gravitational force, and frictional force	3.3.1 Analyzing various types of forces and their influence on an object (C4) 3.3.2 Analyzing muscle force, magnetic force, gravitational force, and frictional force and their benefits in daily life (C4) 3.3.3 Proving the existence of magnetic force, gravitational force and frictional force in everyday life (C5) 3.3.4 Arranging how a magnet works on a crane machine (C6) 3.3.5 Making questions about nails that can be attracted by magnets (C4) 3.3.6 Analyze why the series lamp can light up (C4)

Table 2. The High-Order Thinking Ability Indicators

Dimensions	Indicator
Providing a Simple Explanation	Formulating questions
	Analyzing arguments
	Asking and answering questions about an explanation or challenge
Building Basic Skills	Considering the credibility of a source
	Observing and considering the results of observations
Conclude	Skills in concluding
	Making deductions and considering the results of deductions
	Making inductions and considering the results of inductions
	Creating and determining consideration values
Providing Further Explanation	Defining terms and considering definitions
	Identifying assumptions
Conjecture and Integration	Determining an action
	Making and defending a decision

Second, the self-evaluation stage is a self-assessment of the design of the high-level thinking ability test instrument based on the results obtained at the preliminary stage where the designed test instrument has included test grids, test questions in the form of descriptions, test answers, and scoring guidelines. The analysis stage consists of four activities, namely student analysis to obtain student needs data, curriculum analysis to determine the expectations of the curriculum to produce students with 4C skills through HOTS-based learning and evaluation, analysis of devices or materials to be developed to determine the

type of learning device to be developed in this case is a learning evaluation in the form of a descriptive test, and the design of the instrument developed.

Third, the formative evaluation stage is divided into 2 activities, namely the expert test stage and the field trial. At the expert test stage, the instrument that has been prepared is tested for its content validity according to the content, construction, and language of each question item. Experts in this case are lecturers and also teachers in the field of science. Based on calculations through the Gregory test, it was obtained that each question item was relevant and could be continued to the field test stage to determine the validity of each question item empirically. Then in the field test, the questions were tested on students as research subjects, the results of which were analyzed for reliability, level of difficulty, and differentiating power in order to continue to further testing. Based on the internal consistency test, the results showed that 3 questions were invalid because they obtained a calculated r value < r table so that there were 17 valid questions. At the internal consistency stage of the items, the test is said to be reliable if the test provides consistent and stable results every time it is measured or applied.

Based on the measurement results using Alpha Cronbarch, the results obtained were 0.78, meaning that the questions used were reliable because they were greater than the minimum reliability coefficient of 0.60. Furthermore, a discriminatory power test was conducted to determine the ability of the test items to distinguish students who were classified as capable from students who were classified as unable. Based on the calculation results using the Ferguson formula assisted by the R Studio application, the results obtained were 3 items in the moderate category and 17 others in the high category. Based on the results of the HOTS analysis through item fit (level of suitability of questions) and the Generalized Partial Credit Model (GPCM), the Mean Square (MNSQ) outfit value ranged from 0.41 to 1.49. The ZSTPD outfit value received: -2.0 <ZSTPD < +2.0. Finally, the Point Measure Correlation (Pt Measure Corr) value ranged from 0.26 to 0.58. Based on the GPCM results, it is known that students with absent number 1 have high abilities because they have high scores and have a logit value of 2.5, while student respondents with number 75 have low abilities because they have low scores and have a logit value of -0.30. And based on the results of the high-level thinking test, it can be obtained that 47.2% of students have high high-level thinking skills, 52.8% have moderate high-level thinking skills, while no students have low high-level thinking skills.

Discussion

The results of the analysis show the internal consistency of the high-level thinking test items.17 questions were declared valid based on the validity test using the R Studio software. This finding shows that the science essay question instrument to measure high-level thinking skills of elementary school students, seen from the validity of the items, is able to measure consistently according to what should be measured. Thus, it can be concluded that although there are some questions that are considered invalid (15%), overall this high-level thinking ability test instrument has a coefficient of 0.45 meeting the validity criteria in the moderate category. Reliability measures the extent to which a test can be relied on and provides accurate results. From the trials conducted, it can be seen that the test instrument to measure high-level thinking skills of elementary school students that was developed has high reliability. This can be seen based on the results of the test reliability analysis using the R Studio software on the question items. This shows that the science essay question instrument to measure high-level thinking skills of elementary school students in terms of test reliability can be said to have met the reliability standards with reliability criteria in the high category.

The discrimination index is a test item assessment that is intended to determine the ability of test items to distinguish students who are classified as capable from students who

are classified as unable. The discrimination index of test items is calculated using the Ferguson formula assisted by R Studio software. Three questions are in the medium category and 17 other items are in the high category. These questions are still able to distinguish between participants with different abilities, but are not as effective as questions in the high category. Furthermore, items with high d indicate that these questions are effective in distinguishing between participants with high and low ability levels. Participants with high abilities tend to answer correctly, while participants with low abilities tend to answer incorrectly. Based on this study, items with high d are more prioritized for use in the field.

The test of the level of difficulty of the test instrument to measure the high-level thinking skills of elementary school students that was developed showed that the level of difficulty of the items was in the medium category. Items with a medium I (Item Difficulty Index) showed a fairly balanced level of difficulty. These questions have a medium level of difficulty which means that the questions can be answered by all participants, although not too easy, and can also be answered by most participants, although not too difficult. As a note, the higher the I value, the easier the question is. Thus, the high-level thinking ability test instrument for elementary school students in terms of item difficulty has good quality and the item difficulty index is in the medium category. Measuring item fit is very important to ensure that each question makes a maximum contribution to the overall measurement objective (Afrita & Darussyamsu, 2020; Umami et al., 2021). This will ensure that the test items on this device are indeed appropriate and have good quality if later used to measure students' high-level thinking skills. From the results of the analysis, it was found that the high-level thinking skills of students who worked on the questions on the high-level thinking test can be seen that as many as 47.2% of students who have high high-level thinking skills, 52.8% have medium high-level thinking skills, while no students have low high-level thinking skills.

The use of high-level thinking instruments in learning activities can maximize the learning process so that students are able to compete in the 21st century as it is today. The application of high-level thinking skills in the learning process and learning evaluation can affect students' success in improving high-level thinking skills in everyday life. The implication of this study is that the instruments developed can be used. This finding is reinforced by the findings of previous studies stating HOTS instruments to improve high-level thinking skills in elementary school students in mathematics subject matter (Rahayu et al., 2020). Mathematics learning outcome instruments oriented towards high-level thinking for elementary school students (Rahman & Ririen, 2023).The contribution of high-level thinking instruments is a new instrument that can be applied by teachers so that teachers know students' skills. However, because the instruments developed are limited to science content on heat transfer material, they can be re-developed in other lesson contents and other materials. So that with high-level thinking instruments applied to each lesson content, it can provide students with the opportunity to have high-level thinking skills. The implication of this research is that the questions that have been developed can be used by teachers to measure the effectiveness of learning according to student needs.

4. CONCLUSION

The results of the study showed that the prototype of the high-level thinking test for elementary school students in science material developed consisted of 1 package on science material in the form of essays to measure high-level thinking skills. High logit values indicate high problem-solving abilities. This is related to high question correspondence. This means that students' chances of answering questions correctly follow the level of question ability. The more difficult the question, the smaller the chance of students answering correctly. The

suggestion for this study is that the test developed can be used to improve high-level thinking skills, improve students' conceptual understanding related to science material, and evaluate learning. Provision of adequate facilities so that students' high-level thinking skills develop optimally. For other studies, it can help in the development of better and more sustainable high-level thinking test instruments for other KD in making science questions.

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