

Analysis of High Order Thinking Skills (HOTS) in Objective Test Questions for Science Learning Material in Fourth Grade Elementary School

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ABSTRACT

Test instruments are crucial assessment aspects for students, utilized to gauge their knowledge abilities during the learning process. Educators or teachers must scrutinize and analyze the tests beforehand to ensure that the questions predominantly assess higher-order thinking skills (HOTS). Learning processes predominantly focusing on lower-order thinking abilities may result in students struggling with questions that require higher-order thinking skills. This study aims to determine the percentage of knowledge dimension aspects, cognitive process dimension, and HOTS content in three supporting books for Science Learning Material in Fourth Grade. It adopts a quantitative descriptive research approach, analyzing a population of 400 multiple-choice questions from three supporting books, with a sample size of 400 questions. Data collection techniques involve observation and documentation methods, utilizing document analysis guideline sheets as instruments. Findings reveal that the percentage of knowledge dimension results across the three supporting books indicate: factual dimension (23.2%, 34%, and 42%), conceptual dimension (54.8%, 47%, and 40%), procedural dimension (19.6%, 16%, and 16%), and metacognitive dimension (2.4%, 3%, and 2%). Regarding cognitive process dimension and HOTS content (C4 to C6), the supporting books yield: remembering level (C1) ranging from 27.2% to 40%, understanding level (C2) ranging from 32.4% to 40%, applying level (C3) ranging from 8% to 12.8%, analyzing level (C4) ranging from 8% to 22%, evaluating level (C5) ranging from 3% to 7.2%, and creating level (C6) ranging from 0% to 1.6%. According to these findings, the

three supporting books for Fourth Grade Elementary School Science Learning Material do not adequately meet the criteria for fostering higher-order thinking skills.

Keywords

Cognitive processes
Elementary education
Higher-order thinking
Learning assessment
Metacognition
Test instruments

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Introduction

Education is pivotal for individuals to attain high-quality, intellectually rich, and insightful knowledge, enabling them to adeptly navigate various aspects of societal life [1]. In pursuit of enhancing educational quality, the Indonesian government, through the Ministry of Education and Culture, formulated the "Merdeka Belajar" curriculum policy as a remedial curriculum initiative to address the learning crisis and stark educational disparities across regions in Indonesia [2].

Test instruments serve as pivotal assessment components for students, employed to measure their knowledge abilities within the learning process. Tests are categorized into two main types: objective tests (multiple-choice, matching, true/ false) and subjective tests (essay or descriptive questions). Among these, objective multiple-choice tests have proven to be quite effective for assessing broader learning materials. Consequently, multiple-choice objective tests serve as an alternative solution for daily assessments, mid-semester assessments, end-of-semester assessments, end-of-year assessments, and school exams. However, the widespread adoption of these tests by teachers does not necessarily ensure their quality and alignment with students' needs. As highlighted by Ref. [3], many teachers struggle to craft high-quality test questions. This often results in teachers resorting to various sources such as worksheets, interactive books, question banks, or the Internet for test materials.

The quality of tests is not only influenced by teachers' reliance on supporting materials but also by the lack of thorough analysis and review of the test questions before they are administered to students. Consequently, test items predominantly assessing lower-order thinking skills (LOTS) may lead to students experiencing difficulties with questions that demand higher-order thinking skills (HOTS). Concurrently, with stagnant PISA scores over the past decade to fifteen years, indicating significant disparities across regions and socioeconomic groups in terms of students' learning quality [4].

HOTS stimulates critical thinking, problem-solving, and decision-making abilities among students. HOTS encompasses the skills of analyzing (C4), evaluating (C5), and creating (C6). Teachers must foster higher-order thinking skills among students to equip them with problem-solving capabilities applicable to their daily lives [5]. Textbooks serve as vital tools in enhancing higher-order thinking skills during the learning process [6]. Therefore, an increase in the incorporation of higher-order thinking skills in supporting textbooks enhances the likelihood of imparting these skills to students. Thus, based on the aforementioned background, the researcher is motivated to conduct an in-depth study on HOTS in multiple-choice objective test questions within three supporting textbooks for Science Learning Material in Fourth Grade. Building upon the aforementioned background, the research focuses on the following problems:

1. What is the percentage of knowledge dimension aspects in three supporting textbooks for Science Learning Material in Fourth Grade?
2. What is the percentage of cognitive process dimension in three supporting textbooks for Science Learning Material in Fourth Grade?
3. What is the percentage of HOTS content in three supporting textbooks for Science Learning Material in Fourth Grade?

From these problem formulations, the research aims to achieve the following objectives:

1. To determine the percentage of knowledge dimension aspects in three supporting textbooks for Science Learning Material in Fourth Grade.
2. To determine the percentage of cognitive process dimension in three supporting textbooks for Science Learning Material in Fourth Grade.
3. To determine the percentage of HOTS content in three supporting textbooks for Science Learning Material in Fourth Grade.

Material and Methods

The research conducted in this study employs a quantitative descriptive research design. To facilitate the research process, the researcher assigned codes to the three books in Table 1. The sampling technique employed in this study is saturated sampling, where all members of the population are included in the research sample [7]. The research variable is the presence of HOTS content in the test items within the supporting textbooks for Science Learning Material for Fourth Grade. Data collection techniques include observation and documentation. Documentation involves selecting books, worksheets, or question banks containing Science Learning Material for Fourth Grade from various bookstores in Yogyakarta. Following the observation, three supporting textbooks for Science Learning Material from

different publishers were selected for the study. The document used to collect data in this research is a document analysis guideline sheet.

Table 1. Book's identity

No	Title	Authors	Publisher	Year	Amount of analyzed items
1	<i>IPAS SD/MI Kelas IVB (Buku Interaktif)</i> [Interactive Book of Science and Social Learning Material for Fourth Grade]	Hastyorini & Wijayanti	Intan Pariwara	2022	250
2	<i>Alam dan Sosial Berbasis Profil Pancasila untuk Siswa SD/MI Kelas 4</i> [Science and Social Learning Material Based on Pancasila Student Profile for Fourth Grade Elementary School]	Tim Studi Scientia	Yrama Widya	2022	100
3	<i>Splash Ilmu Pengetahuan Alam dan Sosial SD/MI Kelas IV</i> [Splash Book of Science and Social Knowledge for Fourth Grade Elementary School]	Dian	Yudhistira	2022	50
				Total	400

The validity of this research lies in construct validity. After constructing the instrument based on a specific theory, it was consulted with expert lecturers. In this study, the expert validation of the instrument in analyzing HOTS in objective test questions was conducted by an expert. Instrument reliability was tested using internal consistency. This was achieved by administering the instrument once, thus the testing was conducted only once. Data analysis techniques involve analyzing the sample using an instrument for analyzing the test items of Science Learning Material for Fourth Grade according to the revised Bloom's taxonomy, which was reviewed and approved by the expert validator. Data results were grouped, counted, and then calculated for percentages. Percentage calculations include dimensions of knowledge (factual, conceptual, procedural, and metacognitive), cognitive process dimensions (remembering "C1", understanding "C2", applying "C3", analyzing "C4", evaluating "C5", creating "C6"), and HOTS content if the test items meet the levels of analyzing, evaluating, and creating referring to the revised Bloom's taxonomy. Data analysis was conducted using SPSS (Statistical Product and Service Solutions) version 25, followed by concluding the analyzed research findings.

Results

A. Research Description

Data were analyzed using instruments approved by the expert validator. Based on the obtained data, an analysis of the objective test items was conducted, focusing on the revised

Bloom's taxonomy, which encompasses the dimensions of knowledge and cognitive processes. The revised taxonomy improves upon the original by introducing a two-dimensional framework, namely the cognitive process dimension and knowledge dimension [8]. The cognitive process dimension includes components such as remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6), while the knowledge dimension comprises factual, conceptual, procedural, and metacognitive components. Objective test items were then classified as HOTS items if they met the criteria of the cognitive process dimension indicators: analyzing (C4), evaluating (C5), and creating (C6).

B. Analysis Involving Knowledge Dimensions

The analysis results encompassing the aspects of factual, conceptual, procedural, and metacognitive knowledge dimensions from three supporting books with various publishers were examined. The percentage analysis results for the dimensions of factual, conceptual, procedural, and metacognitive knowledge can be observed, as presented in Table 2.

Table 2. Percentage of Knowledge Dimensions

	Factual	Conceptual	Procedural	Metacognitive
Book 1	23.2	54.8	19.6	2.4
Book 2	34.0	47.0	16.0	3.0
Book 3	42.0	40.0	16.0	2.0

It can be concluded that among the three analyzed books, the conceptual dimension is predominant, while the metacognitive dimension shows the lowest percentage results.

C. Analysis Involving Cognitive Dimensions

The analysis results involving the cognitive dimension aspects ranging from remembering (C1) to creating (C6) from three supporting books were examined. The analysis results meeting cognitive dimensions C1 through C6 are clearly illustrated in Table 3.

Table 3. Percentage of Cognitive Dimensions

	C1	C2	C3	C4	C5	C6
Book 1	27.2	32.4	12.8	18.8	7.2	1.6
Book 2	39.0	28.0	8.0	22.0	3.0	0.0
Book 3	40.0	40.0	8.0	8.0	4.0	0.0

From Table 3, it can be concluded that cognitive dimensions ranging from level C1 to level C6 have average percentage results across the three supporting books analyzed. The largest data result is obtained for the remembering (C1) and understanding (C2) levels, while the smallest data result is observed for the evaluating (C5) and creating (C6) levels.

D. Analysis Involving HOTS Content

The research data from three different publishers' supporting books meeting HOTS criteria (analyzing, evaluating, and creating) were analyzed. From Table 3, it can be concluded that the analysis results of HOTS content, with an average percentage across the four supporting books analyzed, show the highest results for analyzing (C4) HOTS, while the lowest results are observed for the creating (C6) HOTS.

Based on the research conducted on 400 items from three supporting books, the items with knowledge dimensions are presented in Figure 1 above. Among the three analyzed supporting books, the test items varied in terms of knowledge dimensions based on the revised Bloom's taxonomy, which covers factual, conceptual, procedural, and metacognitive aspects. The analyzed test items still have deficiencies, as the proportion division in the factual and conceptual dimensions still dominates in the analyzed items. Additionally, test items referring to the metacognitive dimension are relatively scarce compared to other knowledge dimensions. Consistent with the study conducted by Ref. [9], it is recommended that the level of conceptual knowledge dimension that develops students' conceptual skills should be emphasized to enhance students' ability to solve problems presented in HOTS-based items.

There are three supporting books analyzed, and the analyzed test items still have deficiencies, as the proportion division is dominated by the remembering (C1) and understanding (C2) levels, with low proportions for the evaluating (C5) and creating (C6) cognitive process dimension levels.

The findings of the research conducted on three supporting book contents reveal that the items meeting HOTS levels (C4, C5, and C6) are fewer compared to Lower Order Thinking Skills (LOTS) levels (C1, C2, and C3). This is in line with the studies conducted by Ref. [10]-[13], which state that the percentage of LOTS items is greater than the percentage of items developing HOTS. Additionally, within the cognitive domain, the percentage of items at the evaluating (C5) and creating (C6) levels is not represented in the test items. Detailed results can be observed in Figure 3 presented in a bar chart format. Analyzing level HOTS items is more dominant compared to evaluating and creating levels. However, among the three supporting books analyzed, the HOTS category is still relatively small compared to the LOTS category. The test items from the three supporting books analyzed are still considered inadequate because the proportion distribution in each category is uneven, with remembering (C1) and understanding (C2) dominating the test items. Consequently, the proportion of types of questions that train high-order thinking skills (HOTS) remains very low.

Therefore, it can be interpreted that during learning activities, both in tests and classroom instruction, many students still struggle with HOTS questions due to the dominance of materials that emphasize lower-order thinking skills (LOTS). Based on the research by Ref. [14], it is necessary to conduct further testing and research on the effectiveness of textbooks in fostering HOTS among students at primary and secondary levels. Consistent with the study by Ref. [15], students still rely on basic memorization methods and are not familiar with higher-order thinking skills. Moreover, students tend to be passive in learning activities. Thus, there is a need to develop material characteristics, test questions, and student needs. Based on the research by Ref. [16], the presentation of HOTS items to students is still inadequate, indicating a need for improvement and enhancement of quality aspects in the preparation of test items to make HOTS criteria more dominant.

Conclusion

In conclusion, the analysis of three supporting books within the context of learning content provided valuable insights into the distribution of various cognitive dimensions and the prevalence of HOTS items. Across the examined books, it was evident that conceptual knowledge dominated, while metacognitive aspects were relatively underrepresented. Similarly, in terms of cognitive processes, remembering and understanding levels were more pronounced, while evaluation and creation levels were less emphasized. Notably, the presence of HOTS items, particularly those assessing analytical skills, was limited across all books, suggesting a potential gap in fostering higher-order thinking among students. These findings underscore the importance of curriculum developers and educators in ensuring a balanced distribution of cognitive dimensions and promoting the integration of HOTS items to cultivate critical thinking skills among learners. Further research and refinement of teaching materials are warranted to address these challenges and enhance the quality of learning experiences in education.

Conflict of Interest

The authors declare that there is no conflict of interest.

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