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Assessment of the Difficulty Level of Science Questions Using the TIMSS Question Semantic Evaluation for Grade IV Elementary School Students

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Abstract

The main urgency of this study is to evaluate the semantic difficulty level of TIMSS questions for Grade IV students, considering the impact of semantic difficulty on students' understanding of concepts, which has not been extensively researched. The purpose of this study is to assess the semantic difficulty level of TIMSS questions among Grade IV students at SDN Parsanga II. This study uses a descriptive research method. The research population includes all Grade IV students at SDN Parsanga II, with a sample size of 30 students randomly selected from the population. The research instruments consist of TIMSS questions and a semantic assessment checklist regarding question difficulty levels. Data analysis is conducted quantitatively. The semantic difficulty level of TIMSS questions is determined based on the percentage of correct answers from students, and the question difficulty level is calculated using the percentage of correct answers from the entire student sample. The results of the study reveal that a high number of correct answers indicates a good understanding of the tested concepts, while a high number of incorrect answers suggests difficulties in understanding the concepts or errors in processing information. This analysis provides valuable insights into student performance and question difficulty levels. Based on this understanding, test results can be evaluated more comprehensively, thus improving the quality of learning. Educators can identify students' difficulties and needs in understanding the tested concepts and design appropriate interventions to enhance their understanding.

Keywords: *TIMSS Semantic Evaluation, Science Questions, Grade IV Students, Elementary Education*

Introduction

Educational assessment plays a crucial role in evaluating and understanding the quality of a country's education system. Without accurate and comprehensive assessments, it is difficult to determine the extent to which students can understand and master the fundamental concepts taught across various subjects (Le Hebel et al., 2017). Such evaluations provide a clearer picture of students' abilities to apply the knowledge they have learned in the classroom. Proper assessment also helps identify weaknesses or strengths in the curriculum being taught, as well as providing insights into the effectiveness of the teaching methods employed (Dhema, 2019).

The valuable tool in global educational assessment is international studies such as TIMSS (Trends in International Mathematics and Science Study). This study is not only used to measure students' achievements in mathematics and science but also to compare learning outcomes from students in different countries around the world. TIMSS provides a reliable

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overview of student performance that is useful for policymakers in designing better educational policies by collecting data from various educational systems (Lesiana et al., 2022).

TIMSS also provides valuable data on factors influencing the learning process, one of which is the semantic difficulty level of the questions posed to students (Syarifuddin et al., 2022). This refers to how the complexity of language or terminology used in questions can affect students' ability to understand and answer them (Cahyani et al., 2022). Semantic difficulty, which involves elements such as difficult vocabulary, complex sentence structures, or concepts that are unfamiliar to students, is a key indicator used to evaluate the extent to which students can understand and apply the concepts tested in a particular subject (Yusuf, 2022). Analyzing this semantic difficulty is essential for identifying potential barriers that may hinder students' understanding, particularly in questions that test higher-order thinking skills (HOTS) (Agustin et al., 2022).

Educational assessment that involves analyzing semantic difficulty can provide deeper insights into how well students master the material taught, and offer a foundation for developing more effective learning strategies. Given the importance of semantic difficulty in influencing student comprehension, it is crucial to develop questions that take these semantic factors into account to ensure fair and reliable assessment results at the international level.

Administering TIMSS questions to Grade IV students at SDN Parsanga II is deemed essential. This trial provides a preliminary assessment to gauge their understanding of scientific concepts. The students are building foundational knowledge, and such evaluations offer insights into their abilities at an early stage of their educational journey (Alimuddin et al., 2020). Furthermore, the trials help identify the learning needs of Grade IV students. The analyzing their responses, areas where students face difficulties or lack understanding can be pinpointed. This information is invaluable for designing better teaching strategies, creating relevant curricula, and providing necessary guidance to ensure optimal progress. As Grade IV students transition to higher grades (V and VI), where they face final exams for secondary school admission, TIMSS trials serve as an introduction and preparation for advanced assessments. Familiarizing students with the format and types of questions typical of international assessments equips them.

These trials also benefit teachers by highlighting their students' abilities and positioning within an international framework. The results can be compared to data from other countries, offering insights into students' competencies in a global context and identifying areas requiring improvement to meet higher international standards. The semantic difficulty assessment of TIMSS questions adds depth to understanding the characteristics of the tests used (Anaya et al., 2022). The validity and reliability of TIMSS results, it is crucial to critically analyze the semantic difficulty of each question. This process identifies strengths and weaknesses in question design and improves the evaluation instruments used.

The study aims to explore the significance of assessing the semantic difficulty of TIMSS questions in enhancing students' understanding of critical concepts and its impact on curriculum development and better teaching strategies. Additionally, it will address challenges in semantic difficulty evaluation, including factors influencing the complexity of questions. Comprehensive research on semantic difficulty assessment in TIMSS questions is expected to contribute positively to improving the quality of education globally. The effective learning strategies can be devised to foster deeper comprehension and produce a generation of students more competent in science and mathematics (Kusdianti et al., 2019).

The novelty of this research lies in its focus on analyzing the semantic difficulty level of TIMSS questions for Grade IV elementary school students, an area that remains relatively underexplored in educational assessment. This study applies the TIMSS framework to the local context of SDN Parsanga II, offering insights into how international assessment tools align with the capabilities and learning environment of Indonesian elementary school students. While TIMSS is widely used for evaluating mathematical and scientific competencies, this research uniquely emphasizes the semantic complexity of the questions, aiming to uncover its influence on student comprehension and performance. The study contributes to designing targeted interventions, enhancing a student-centric approach in educational assessments by identifying areas where students face semantic challenges.

The findings are expected to inform curriculum development and teaching strategies that address semantic difficulties, bridging gaps between international assessment standards and local educational practices. Beyond evaluating current student understanding, the research also prepares students for future assessments by introducing them to TIMSS-style questions, fostering early readiness for global competition. The aspects underscore the study's contribution to bridging local and global education standards while advancing methodologies for assessing student learning in elementary science education.

Method

The research employs a descriptive method to analyze and illustrate the difficulty level and semantic evaluation of TIMSS (Trends in International Mathematics and Science Study) questions faced by Grade IV students at SDN Parsanga II. This approach allows for an in-depth understanding of the challenges students encounter when engaging with TIMSS questions, particularly in terms of question difficulty and semantic complexity. The study population comprises all Grade IV students at SDN Parsanga II, with a sample of 30 students randomly selected to ensure representation. These students participated in the study to provide data on their experiences with TIMSS questions. The TIMSS questions used in the research were selected based on their relevance to the curriculum taught in Grade IV and have undergone prior validation to ensure their reliability and alignment with international standards.

Semantic Assessment Sheets were utilized to evaluate the semantic difficulty of the TIMSS questions. These sheets enabled the researchers to assess the complexity of the language used in the questions and how it might affect students' ability to comprehend and answer them. The evaluation process aimed to identify specific linguistic or conceptual elements that could pose challenges to students. During the data collection process, the 30 selected students were given a set of TIMSS questions to complete within a specified time frame. Following the test, the students were asked to fill out the Semantic Assessment Sheets, providing their perceptions of the semantic difficulty level of each question. This step was crucial for correlating students' performance with the semantic challenges they experienced.

This research provides a comprehensive understanding of the factors contributing to the difficulty level of TIMSS questions for Grade IV students by combining performance data with semantic evaluations. The findings are expected to offer insights into how semantic complexity influences student comprehension and performance, with implications for improving teaching methods and curriculum design. The data in this study will be analyzed using both quantitative and qualitative methods to ensure a comprehensive understanding of the difficulty levels of the TIMSS questions and the semantic challenges they present. This dual approach allows for detailed insights into both the numerical performance of students

and the qualitative aspects of question comprehension. The findings are expected to provide a thorough overview of the general difficulty level and the semantic challenges embedded in the TIMSS questions.

The quantitative analysis focuses on determining the general difficulty level of the TIMSS questions. This will be calculated based on the percentage of correct answers provided by the entire student sample. The percentage of students who answered correctly will be computed for each question, and these percentages will be categorized into different difficulty levels (e.g., easy, moderate, difficult). The overall difficulty level of the test will then be summarized by averaging the difficulty levels of individual questions. This numerical representation provides an objective measurement of how challenging the TIMSS questions are for Grade IV students. The qualitative analysis will focus on the semantic difficulty of the questions as evaluated through the Semantic Assessment Sheets. Each question will be examined to identify specific semantic elements that contribute to the students' difficulties. These elements include complex sentence structures, unfamiliar vocabulary, and ambiguous phrases. The analysis will involve categorizing the semantic challenges into themes, such as linguistic complexity, contextual unfamiliarity, or cultural irrelevance. The researchers will then link these themes to the students' performance to determine how semantic difficulties impact their ability to answer correctly.

The results of the quantitative and qualitative analyses will be integrated to provide a holistic view of the TIMSS question challenges. The questions with low percentages of correct answers will be cross-referenced with the semantic analysis to identify whether linguistic complexity or other semantic issues are primary contributors to the difficulty. This integrated approach will highlight patterns and provide actionable insights into improving students' comprehension and performance on similar standardized tests.

This detailed analysis framework ensures that the study not only identifies the difficulty levels of the TIMSS questions but also uncovers the underlying semantic barriers that may impede student understanding, paving the way for targeted interventions in teaching and curriculum design.

TIMSS Story Problem

Question: A farmer is planning to grow crops on his field, which has an area of 250 square meters. He wants to divide the field into two equal sections, one for growing vegetables and the other for growing fruits.

Part A : What will be the area of each section of the field?

Part B : If the farmer plants 5 rows of vegetables in the vegetable section, what is the area used by each row?

Part C : The farmer decides to use a quarter of the fruit section to plant flowers. What is the area of the part used for flowers?

Results

The difficulty level of the questions will be calculated using the percentage of correct answers from the entire sample of 30 students, with a total of 30 questions. The depiction of the question difficulty level is illustrated in the following diagram:

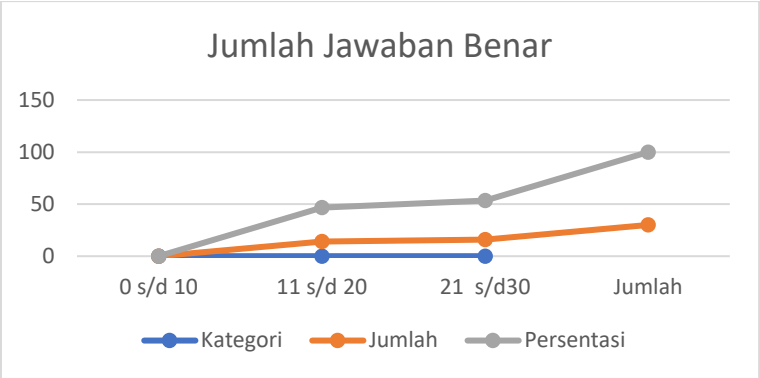

***Figure 1**. Number of Correct Answers*

The data processing results reveal the distribution of students' correct answers across three categories: low, medium, and high intervals. In the "11 to 20" interval category (Medium Number of Correct Answers), 14 students (46.67% of the total sample) achieved between 11 and 20 correct answers. Students in this category demonstrate a moderate level of understanding of the concepts tested in the TIMSS questions. While they have not reached a high level of comprehension, these students exhibit the ability to answer a significant portion of the questions correctly. The interval category of High Number of Correct Answers achieved between “21 to 30”, 16 students (53.33% of the total sample) achieved between 21 and 30 correct answers. Students in this category demonstrate a high level of understanding of the concepts tested in the TIMSS questions. They are able to answer most of the questions correctly, indicating a deep understanding and the ability to apply the tested concepts effectively.

The data show that the majority of students (53.33%) fall into the High Number of Correct Answers category, indicating a good understanding of the concepts tested in the TIMSS questions. Meanwhile, the remaining students (46.67%) are in the Medium Number of Correct Answers category, reflecting a moderate level of understanding of the concepts. These results can serve as a guide for teachers and schools to evaluate and improve effective teaching methods for delivering science concepts to Grade IV students. The distribution of incorrect answers is presented in the following figure:

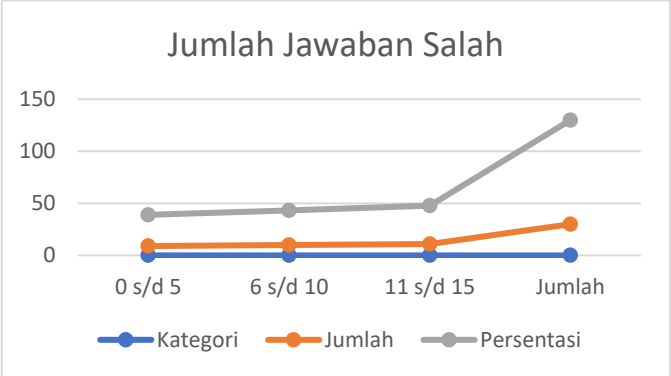

***Figure 2**. Number of Incorrect Answers*

The "0 to 5" interval category (Low Number of Incorrect Answers) includes 9 students (30% of the total sample) who made between 0 and 5 incorrect answers. Students in this category demonstrate good accuracy in answering the given questions. They managed to maintain a low error rate, reflecting a strong understanding of the tested concepts. In the "6 to 10" interval category (Moderate Number of Incorrect Answers), 10 students (33.33% of the

total sample) made between 6 and 10 incorrect answers. Students in this category show a moderate error rate in answering the questions. Although some errors are present, these students still exhibit an adequate understanding of the tested concepts. For the "11 to 15" interval category (High Number of Incorrect Answers), 11 students (36.67% of the total sample) made between 11 and 15 incorrect answers. Students in this category demonstrate a high error rate in answering the questions. They may face difficulties in understanding or applying the concepts tested in the TIMSS questions. The data indicate that the majority of students (63.33%) fall into the Low and Moderate Number of Incorrect Answers categories, demonstrating good accuracy in answering TIMSS questions. However, a portion of the students (36.67%) fall into the High Number of Incorrect Answers category, reflecting a relatively high error rate. These results can serve as a guide for teachers and schools to focus more on improving students' understanding and refining effective teaching methods for challenging concepts.

The difficulty level of the questions is measured using a semantic evaluation for each question. This involves identifying semantic aspects that contribute to students' difficulties. The results of the measurement are illustrated in the following figure:

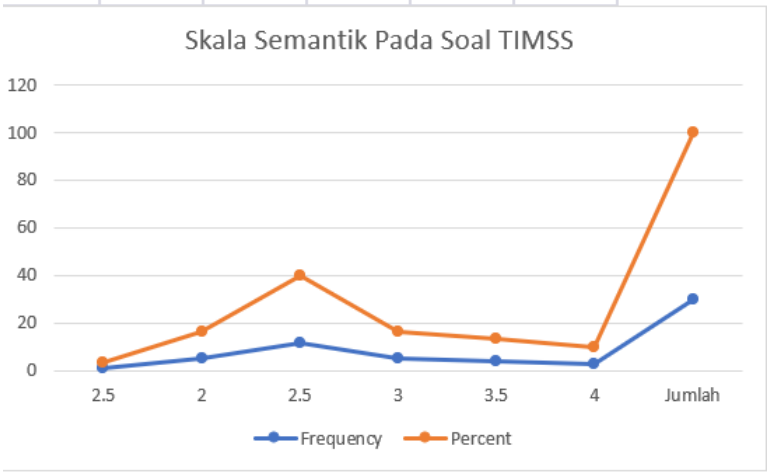

Figure 3. *Difficulty Level Measurement*

The graph above shows that there is one question classified as "Easy" with an interval of 2.5. This question appears once, with a frequency of 1, accounting for 3.3% of the total data. This indicates that the question has a low difficulty level and occurs only once in the dataset. Additionally, there are five questions classified as "Easy" with an interval of 2. These questions have a frequency of 5, accounting for 16.7% of the total data. This demonstrates that questions with a low difficulty level and an interval of 2 appear relatively frequently in the dataset. Furthermore, within the "Easy" category, there are twelve questions with a difficulty level having an interval of 2.5. These questions have a frequency of 12, representing 40.0% of the total data. It can be concluded that the majority of "Easy" questions have an interval of 2.5, and their presence is quite significant in the dataset.

There are five questions classified as "Difficult" with an interval of 3. These questions also have a frequency of 5, accounting for 16.7% of the total data. This indicates that the number of "Difficult" questions with an interval of 3 is relatively the same as "Easy" questions with an interval of 2. Additionally, there are four questions classified as "Difficult" with an interval of 3.5. These questions have a frequency of 4, making up 13.3% of the total data. It can be concluded that "Difficult" questions with an interval of 3.5 also have a significant presence in

the dataset. Lastly, there are three questions classified as "Difficult" with an interval of 4. These questions have a frequency of 3, accounting for 10.0% of the total data. Although fewer in number compared to other "Easy" and "Difficult" questions, these questions still contribute to the overall difficulty assessment.

Discussion

Based on the results of the study on the difficulty level of questions in the TIMSS exam given to 30 fourth-grade elementary school students, it can be concluded that most students demonstrated a good understanding of the concepts being tested. The study revealed that the majority of students (53.33%) were able to answer between 21 and 30 questions correctly, reflecting a deep understanding of the material being tested. This indicates that most students possess a good ability to apply the concepts they have learned and can answer questions effectively. This is in line with research that states students who have a good understanding tend to connect the concepts they have learned with more complex problems in exams, enabling them to answer questions more accurately (Masturah et al., 2021).

The remaining students were categorized as having moderate understanding, with the number of correct answers ranging from 11 to 20 questions, making up 46.67%. Although these students answered most of the questions correctly, they still faced difficulties in understanding some of the more complex concepts or in applying their knowledge to more complex contexts. This indicates that while there is a good basic understanding, there is room to improve students' understanding of more in-depth material, especially in questions that assess higher-order thinking skills (HOTS). The study also found that applying questions with varying levels of difficulty can challenge students to develop their critical and analytical thinking skills (Sari et al., 2019). This study also confirms the findings of previous research that emphasize the importance of teaching that adjusts the level of difficulty of questions to match students' abilities. Research has shown that teaching focused more on questions that require critical thinking skills can help students in the moderate understanding category improve their ability to face more challenging questions (Yusrizal, 2016). This is also consistent with the view that the importance of HOTS questions in exams can serve as an evaluation tool to measure the extent to which students can apply their knowledge to new and complex situations (Putri et al., 2024).

The findings of this study indicate that while most students show a good understanding of basic concepts, some students still need more attention in understanding or applying more complex concepts. Therefore, it is important for educators to design questions with varying difficulty levels, incorporating HOTS questions, to challenge students and encourage them to develop higher-order thinking skills that will be useful in solving problems more analytically and creatively. The distribution of incorrect answers in this study also provides an interesting insight into students' understanding levels. The majority of students (63.33%) had a low to moderate error rate, indicating that they had a fairly good understanding of the material tested. However, about 36.67% of students had a high error rate, indicating difficulties in answering certain questions, especially those assessing higher-order thinking skills. This signals a gap between students' understanding of basic concepts and more complex ones. Previous research has also highlighted that the more difficult the question, the greater the likelihood that students will answer incorrectly, reflecting the challenge of understanding more in-depth material (Rahma & Akib, 2023).

The importance of adjusting teaching approaches is a key focus of this study. For students who are in the moderate understanding category or those who show a higher error rate, it is crucial for educators to adjust their teaching approach, focusing more on the more difficult concepts and introducing questions that develop analytical and critical thinking skills. This is because some students struggle to tackle questions that assess higher-order thinking skills (HOTS), which focus on analysis, synthesis, and the application of concepts in broader contexts. The results of this study align with findings that integrating HOTS questions in national exams can help develop students' critical thinking abilities (Putri et al., 2019).

Based on the distribution of question difficulty, the results of this study show that most of the questions categorized as "Easy" had lower difficulty levels, with many questions falling within the difficulty range of 2 to 2.5. These questions appeared more frequently and were answered well by most students, reflecting their mastery of the basic concepts that had been taught. Conversely, questions categorized as "Difficult" had higher difficulty levels, with most of the questions falling within the 3 to 4 difficulty range. Although fewer questions were categorized as difficult, these questions still played an important role in assessing the overall difficulty level and in identifying areas that require more attention in teaching. Previous research has also shown that challenging questions can encourage students to delve deeper into the material and sharpen their problem-solving skills (Hidayatullah et al., 2022).

The results of this study provide valuable insights for educators and policymakers in designing more effective curricula and teaching strategies. The distribution of question difficulty levels and student performance, educators can more easily identify areas that require more attention in teaching, particularly on more challenging concepts or those requiring higher-order thinking skills. These findings also support the integration of HOTS questions in national exams, which aims to improve students' ability to think critically and solve more complex problems (Sari & Ekayanti, 2022). This research can serve as a solid foundation for designing learning materials that are more appropriate for students' abilities and for improving the quality of education at the elementary school level.

This study not only contributes to understanding the difficulty level of TIMSS questions for fourth-grade elementary school students but also provides a solid basis for the development of a more relevant curriculum and better teaching strategies. This research can help improve the quality of education in the future and provide students with better opportunities to prepare for international exams like TIMSS and PISA, which assess students' higher-order thinking abilities in a global context.

Conclusion

Based on the results of the study titled Assessment of the Difficulty Level of Science Questions Using the TIMSS Question Semantic Evaluation for Grade IV Elementary School Students, it can be concluded that the majority of students demonstrated a good understanding of basic concepts in the TIMSS exam, with more than 50% of students able to correctly answer 21 to 30 questions. However, a portion of the students (46.67%) showed a moderate understanding, with a higher error rate on questions testing higher-order thinking skills (HOTS). These findings indicate the importance of designing questions with varying difficulty levels that can encourage students to develop critical and analytical thinking skills. The study also confirms that teaching tailored to the difficulty levels of questions can help students overcome challenges in tackling more complex questions.

The limitation of this study is the small sample size, involving only 30 students, which may not fully represent the broader student population. Additionally, the study did not explore other factors that could influence exam results, such as the impact of teaching methods or other external factors. The recommended for future research to involve a larger sample and consider various other variables that could affect student learning outcomes. Further studies could also examine the effectiveness of incorporating HOTS questions into the curriculum more deeply, as well as its impact on students' critical thinking and problem-solving abilities.

Acknowledgment

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