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Complexity Analysis of Integrated Science Test Item Global Competence on Environmental Sustainability Content

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Abstract: This qualitative descriptive analysis aims to interpret the complexity of the science items that are integrated with environmental sustainability content. This research was conducted on science test items in the 2013 Curriculum student science textbooks released by the Ministry of Education and Culture of the Republic of Indonesia. This study focuses on finding out the complexity of the scenario-based science test contained in science textbooks based on the complexity category indicators of the 2018 PISA global competency test. The data was obtained using an instrument adopted from the test complexity indicator and environmental sustainability content indicators contained in the 2018 PISA Framework. The data analysis technique uses the percentage formula to determine the proportion. The results of this study indicate that the proportion of science test items is different from the standard proportion of the 2018 PISA global competency test. The subdomains measured in the 2018 PISA global competence are; the resource risk subdomain and subdomains of policies, practices, and behaviors for environmental sustainability. However, science test items cover only the resource risk subdomain. Therefore, the researcher recommends further research to develop science test items that consider the complexity of the test according to the goals of students' global competence.

Keywords: Complexity, Environmental sustainability, Global competence.

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Introduction

To succeed in this new global era, students not only need capacities that include reading, mathematics and science, but they must be much more knowledgeable and curious about world regions and global issues, aligned with diverse perspectives, able to communicate across cultures with other languages, and tend to act for the common good (Mansilla et al, 2013). In PISA 2018, in addition to measuring mathematical literacy, reading, scientific literacy, and financial literacy, PISA also measures students' global competence. Strengthening global competencies is essential for students to thrive in a rapidly changing world (Hu & Hu, 2021). Global competence is still considered a relatively young construct in a scientific context. Relevant and significant research findings have only been written in recent years (Salzer, 2018). Global competence refers to the acquisition of in-depth knowledge and understanding of international issues, appreciation and ability to study and work with people from diverse linguistic and cultural backgrounds, proficiency in foreign languages, and skills to function productively in an interdependent world community (Van, 2010).

According to Pentury (2019), global competence is the ability to continuously communicate with others, knowledgeable, respectful, understanding ability, having a personality as an important figure, able to think diversely, have different opinions, able to work in a team, and able to solve problems and provide solutions. . There are several functions of global competence, including being able to help ensure the new generation cares about global problems and finds solutions to social, political, economic and environmental problems (OECD, 2019). It is important that preschool through college students begin to develop a deeper understanding of the world's economic, social, and political issues. Global competence in the 21st century is not a luxury but a necessity (Van, 2010). Simply put, to prepare students to participate fully in todays and future world demands, it is necessary to maintain their global competence which is here defined as the capacity and disposition to understand and act on important global issues (Mansilla et al, 2013).

Based on the OECD (2019), there are four dimensions that are measured in the global cognitive competency test, namely: 1) students' ability to understand global and intercultural problems. 2) the ability of students to recognize different perspectives by considering the context (culture, religion, region). 3) students' ability to understand the context of norms and communication. 4) the ability of students to understand the possibility of action on global issues and consider the consequences. However, the results of the 2018 PISA test which measures students' global competence in the cognitive dimension show that Indonesia is among the countries with the lowest scores because the proportion of students' correct answers does not reach 30 percent, along with Albania, Kazakhstan, Morocco, Panama, the Philippines, and Thailand, in contrast to Singapore which shows the largest proportion of answers (OECD, 2020).

Schools play an important position in assisting the younger generation in developing global competencies. Schools must provide opportunities for students to truly evaluate global growth (Bennett, 1993). In this case, schools that want to develop global competencies must focus on clarity and learning objectives. This means

engaging all educators to concentrate on globally significant topics for teaching. This can be seen from the results of Lawless' research (2015), which shows that the implementation of the global education curriculum shows positive changes in students' self-efficacy in writing, priorities in exploring potential possibilities for science education, and students' scientific work performance. Learning activities that emphasize global competence integrate ongoing social topics as student learning topics. This has a positive impact on students. Bednar et al (1992) also say that for decades, researchers have shown that using interdisciplinary contexts such as social science provides students with opportunities to solve actual problems that can improve student understanding. In addition, to grow global competence, students can be given knowledge strengthening through continuous learning (Kim, 2017).

One of the things that need to be considered for significant learning to develop students' global competencies is learning resources because this is very influential in the learning process. Gay (2013) states that student textbooks can be sensitive in terms of student cultural and ethnic differences related to the development of student competencies globally so teachers and students must analyze their textbooks critically. Therefore, this study tries to analyze the tests contained in science textbooks based on their support for the development of students' global competencies. Global competence was well evaluated in the 2018 PISA cognitive test through a scenario-based test (OECD, 2019). Scenarios focus on global issues and intercultural situations where there are different perspectives, and voice these different perspectives. Students will work on several short scenarios, and thus will be able to demonstrate their capacity to think about various issues that have been deemed meaningful, relevant and accessible to 15-year-olds around the world, as determined by experts and by PISA countries who reviewed the test material (Piacentini, 2017).

One of the global competence domains is environmental sustainability content (OECD, 2020). This domain focuses on the risk of resources, so that in this study an analysis was carried out on testing on subjects related to the content of environmental sustainability. In this regard, in this study, an analysis of the complexity of the test on science subjects for junior high schools was carried out which was integrated with global competence, especially in the content of environmental sustainability.

Method

This research is a qualitative descriptive study using the document study method. This study describes the complexity of the test items and the scope of integration of Global competencies that refer to the 2018 PISA test. The test items are obtained from students' science textbooks released by the Ministry of Education and Culture of the Republic of Indonesia. The test items analyzed are questions that are integrated with global competence. Questions that are integrated with global competence are selected by looking at the content of the test item. One of the global competency contents is Environmental Sustainability, so that the test items analyzed are taken from certain learning materials, namely materials that are in accordance with the global competency content (Environmental Sustainability content) based on PISA 2018. Therefore, the topic chosen is

Environmental Pollution (Science Textbooks grade 7), Global Warming (science textbooks grade 7), Soil Pollution (science textbooks grade 9) and Environmentally Friendly Technology (science textbooks grade 9). Of the four topics, this study focuses on scenario-based test items, adapted to the type of Global PISA 2018 competency questions.

The data was obtained from the analysis of science test items and strengthened by the teacher's perspective obtained through in-depth interviews with science teachers as data triangulation. The instrument used to analyze the items was adopted from the complexity category indicators of the 2018 PISA global competency test. The research procedure includes 1. Researchers determine science textbooks to be analyzed, 2. Select topics based on the integration of PISA 2018 global competencies (environmental sustainability content), 3. Selecting scenario-based science test items on the chosen topic, 4. Analyzing science test items, 5. Conducting interviews with teachers. The data analysis technique of this research is to use the percentage formula to determine the proportion of integration of global competence and the complexity of the test items and the category of complexity of the science test items.

Results

The Environmental Sustainability Domain consists of: a) resource risk subdomain and, b) environmental sustainability policy, practice, and behavior subdomain. The results showed that the science test items covered topics according to the global competency content in the subdomain of resource use risk. However, the science tests did not find any items measuring policy, task, and behavioral subdomains for ecological sustainability that focused on what policymakers and individuals can do to reduce overexploitation and deal effectively with environmental threats. The results also show that not all science test items contained in science textbooks are scenario-based. The results showed that the scenario-based test questions were less than 50% in both grade 7 textbooks and grade 9 textbooks. The data can be seen in Figure 1 and Figure 2.

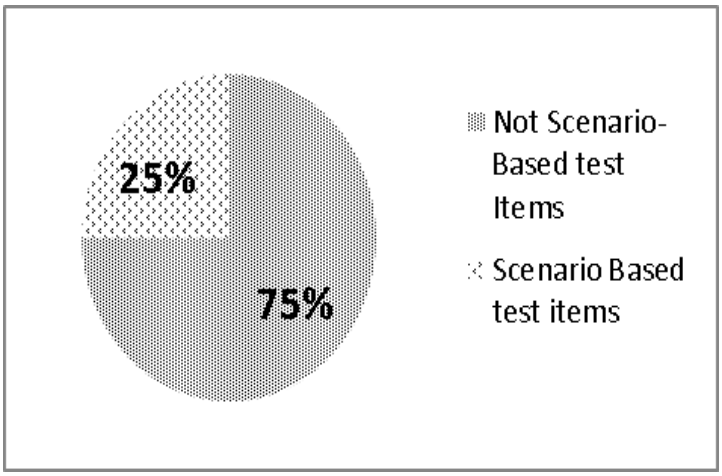

Figure 1. Percentage of Scenario-based Science Test Items (7th Grade)

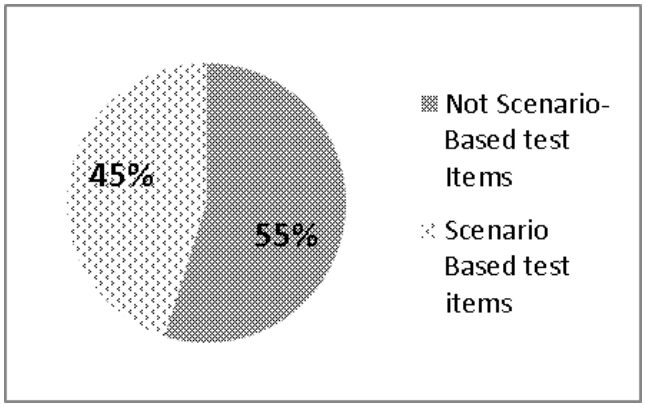

Figure 2. Percentage of Scenario-based Science Test Items (9th Grade)

The results also show that when compared, the test items contained in textbooks are different from the proportion of standard PISA 2018 global competency test items. The following is the complexity standard of the 2018 PISA test which can be seen in Table 1.

Table 1. The Standard for Complexity of the PISA 2018 Global Competence Test Unit

Complexity Indicators	Low	Medium	High
Specific Knowledge	Around 40%	Around 40%	Around 20%
General Knowledge	Around 60%	Around 30%	Around 10%

The indicator of the complexity of the Global competency test items based on the 2018 PISA Global Competence framework consists of aspects of specific knowledge and general knowledge. In the aspect of specific knowledge, the complexity of science questions in textbooks can be said to be disproportionate if it refers to the standard proportion of the 2018 PISA test. This is because science test items have a complexity percentage range that is much different from the complexity of the PISA test items. When compared, the IPA test items with medium complexity exceed the percentage of PISA test items, while the items with low and high complexity are less than the percentage standard of PISA test items. The comparison of the percentage of complexity between the science test items and the PISA global competency test items in more detail can be seen in Figure 3.

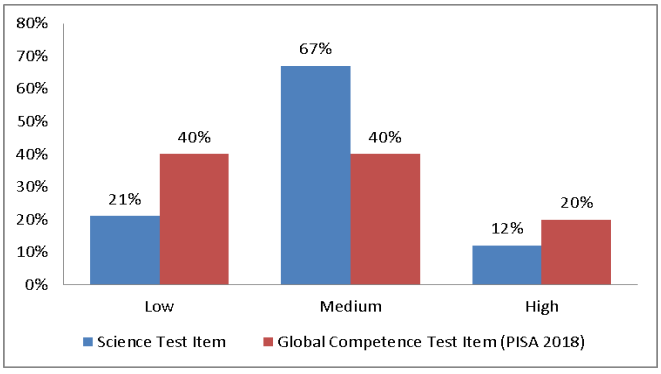

Figure 3. Complexity of Science Test Items on the Specific Knowledge Indicator

Science items are dominated by test items with moderate category complexity, namely the topics/problems used in the test items are mostly known by students but not all topics are naturally popular for them. This is reinforced by the results of interviews, where the teacher said that the content of the material used in the science test items was not diverse and tends to make students bored, the context in the question does not introduce students to a wider context. Meanwhile, the percentage of test items in the high and low complexity categories has not yet reached the proportion of the 2018 PISA test standards. The test items included in the low complexity category are the topics used in the unit tests are very simple and are familiar to most students. Meanwhile, the test items included in the high complexity category are when most of the students have heard about the topic/problem, however, only a small number of students can understand the test topic.

Similar to the category of test items based on specific knowledge indicators, the complexity analysis of science test items based on general knowledge indicators (language and text) is also different from the proportion of complexity of PISA 2018 test items. This can be seen in Figure 4.

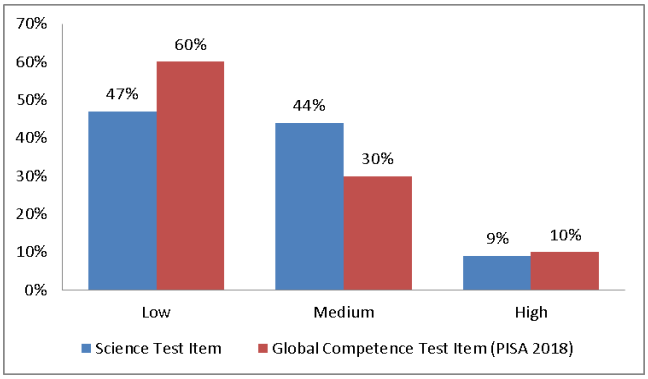

Figure 4. Complexity of Science Test Items on the General Knowledge Indicator

The language and texts used in the science test items are dominated by test items with low complexity categories, namely the scenarios in the test items using very simple language, without words or technical expressions that are typical of certain socio-cultural or demographic groups. However, when compared to the PISA 2018 global competency test items, the percentage of test items with low complexity has not yet reached the PISA test item standard, test items with moderate complexity exceed the standard percentage of PISA test items, while the percentage of IPA test items with high complexity is in accordance with the complexity of the test items. global competence PISA 2018.

The category of moderate complexity characterized by the language in the scenario is familiar to most 15-year-old students. Word choice is typical of communication addressed to a non-specialist audience. The high complexity category is characterized by scenarios in the test items using more complex language which is typical of formal writing or professional conversation, and may include a limited amount of technical or content-specific vocabulary.

Discussion

This study specifically analyzes scenario-based IPA test items that are integrated with environmental sustainability content. In scenario-based unit tests, students read about a problem and respond to test material that assesses their ability to understand multiple perspectives from the various factors involved. Scenario problems describe various situations and test students' ability to apply their experiences and cognitive abilities to analyze situations and suggest alternatives. The test item instructions ask students to critically analyze statements and information so that the results of students' answers will provide relevant information about the student's capacity.

Scenario-based test items in science textbooks were analyzed based on the complexity of the test items. The category complexity of the PISA 2018 global competency test items consists of 3 categories, namely the low category, medium category, and high category (OECD, 2019). The indicator for categorizing the complexity of the items is divided into two components, namely specific knowledge and general knowledge. Specific knowledge is the topic domain covered in the test items, while general knowledge is about the language and texts used in the test items. The results show that the science items contained in the science textbooks have varied complexity, but are very different from the proportion of the complexity of the 2018 PISA items used to measure students' global competence.

The results show that the science test items on the special knowledge component are dominated by items in the medium complexity category, but there are still few test items with high complexity topics. The scenarios in the test items should represent diversity so that students can be aware of global problems or investigate the complexities of cultural relationships (OECD, 2019). This may be one of the factors for the low global competence of students in Indonesia because they are not accustomed to working on test questions with high complexity, namely with a wider context of diversity.

In addition, although language and text are not integral components of global competence, the language used in the test item scenario will definitely affect the level of difficulty of the test item. The low global competence of students may be influenced by the support of teaching materials, including test items that are usually done by students. One of the learning resources used in the learning process is teaching materials (Syam, 2017). Teaching materials are an arrangement of materials that have been collected and derived from various sources that are made systematically (Prastowo, 2011). Learning resources are components of the instructional system which include messages, people, materials, techniques and the environment that can affect student learning outcomes (Duludu, 2017). Textbooks are dominant as a learning resource, of course, textbooks greatly determine the direction of learning implementation (Lasminawati, 2019). From some of these explanations, it can be said that the textbooks and test items contained in the textbooks affect student learning outcomes. In order for students to have good global competencies, global competencies must also be integrated in student learning resources.

Global Competence consists of several domains, one of which is the domain of environmental sustainability content. Environmental Sustainability Domain consists of: a) resource risk subdomain and, b) environmental sustainability policy, practice, and behavior subdomain. The results showed that the science test items only covered the subdomain of resource use risk. Within the subdomain of environmental sustainability policy, practice and behavior, the scenario should ask students to focus on existing instruments and items (eg, standards, taxes, subsidies, education), promoting sustainable consumption and manufacturing, how environmental issues are shared in the media; how the government sees the threat of environmental degradation when making economic policies, as well as environmental concerns about how sustainable development is understood (OECD, 2019).

The absence of science test items that integrate policy and practice will certainly affect students' global competence. Students will be less trained in providing scientific arguments regarding their opinions on global issues related to policies issued by the government. This influence can also be seen from the results of Lawless's research (2015) which shows that the results of implementing a curriculum that integrates global education shows positive changes in students' writing self-efficacy, interest in pursuing science education opportunities in the future, and the quality of students' scientific arguments. The integration of global competencies in learning resources and science test materials can greatly help students have good global competencies.

Conclusion

The results of the study indicate that there are science test items that are integrated with global competencies, especially those related to environmental sustainability in science textbooks for junior high school students. The proportion of complexity of science questions varies, namely low, medium, and high, but it is not the same when compared to the percentage of PISA 2018 global competency test items that do not meet the standard for the proportion of test component complexity used in the 2018 PISA Global competency test. Based on the specific knowledge component indicators, the percentage of questions Science in textbooks with low complexity is 21%, medium complexity is 67%, high complexity is 12%. In addition, based on indicators of general knowledge components (language and text), the percentage of science questions in textbooks with low complexity is 47%, moderate complexity is 44%, high complexity is 9%.

Recommendations

The recommendation from the results of this study is that it is hoped that in the future the science test items that will be developed pay attention to the complexity of the science test items with the right proportions, and integrate global competencies that not only integrate environmental sustainability material in theory but also integrate activities and attitudes in management of the environment, focus on what governments and policymakers and individuals can do to reduce wastage of resources and better address environmental risks. With learning resources that contain policies, practices, and environmental sustainability behavior, it is hoped

that students will be better trained to give arguments and try to describe opinions and solutions from various perspectives.

Notes

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