



Students' Socio-scientific Reasoning to Measure Decision-Making Ability Related to Sustainable Energy Issues

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Abstract: Along with the development of the era and technology and the increasing human population, the need for energy use is increasing. This study aims to measure students' reasoning and decision-making abilities related to socio-scientific problems. This study uses quantitative research with a cross-sectional survey research design. The research sample was determined by purposive sampling, and 26 samples were collected from class VII B at SMPN 1 Sambit Ponorogo. Measurements in this study were carried out through 2 tests: the first was a multiple-choice test, and the second was a descriptive test. The results of this study show that the Cronbach Alpha value in the form of interaction between person and item items as a whole, worth 0.72, is a "Good" level. Then, it shows the person reliability value or respondent reliability of 0.65 and item reliability or instrument reliability of 0.10. This shows that the consistency of respondents' answers is in the "good" category. Thus, this study can provide a direction for further developing more effective learning approaches and methods to improve students' abilities in dealing with complex issues.

Keywords: decision-making ability; energy; socioscience; sustainability

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INTRODUCTION

The development of technology and the increasing number of human population have caused the use and demand for energy to increase. As we know, humans use energy for various purposes, from economic needs to personal needs. Energy consumption is a definite and inseparable thing in everyday life, including in the development needs of a country. Indonesia is one of the countries with the most considerable energy or resource consumption in Southeast Asia. It is in fifth place with the most enormous energy consumption in Asia (Damayanti et al., 2020). Indonesia is dominated by limited fossil energy consumption compared to renewable energy consumption. Thus, there are challenges related to providing sufficient energy to meet the community's needs without damaging the environment. Using renewable energy such as solar, wind, water, geothermal energy, etc., can be considered a solution to sustain global needs (Fourniyati, 2023; Gumelar et al., 2019).

Renewable energy should be known conceptually and applied in everyday life, especially for students who are also part of society. Society must be able to think ahead and make the right decisions to respond to socio-scientific issues for the sake of sustainable life and maintaining natural resources so that they remain sustainable. Using renewable energy such as solar, wind, water, and biomass has great potential to reduce dependence on fossil fuels because these energy sources are environmentally friendly, renewable, and more supportive of environmental sustainability (Tatsar et al., 2022). Students or students are expected to be able to think about the future and consider the long-term impacts of decisions made related to socio-scientific issues, especially on problems regarding this energy. Education about renewable energy not only provides basic knowledge, such as what energy is or types of energy, but also improves the ability of society to make the right decisions and their impact on the environment as a whole (Amelia & Chusni, 2024).

Amid technological developments, developing science education skills is considered necessary to train students to have high-level thinking skills or critical, creative, and innovative thinking. These skills will later make students better understand that science education is not only focused on concepts and theories but also focuses on the ability to observe, ask questions, collect data, analyze data, and draw conclusions (Nugroho & Airlanda, 2020; Nurcahyani, 2024; Pramudawardani & Prasetyo, 2021). The issue of sustainable energy also needs to be understood by students because science learning is learning that is closely related to nature. In addition, science education will always be related to activities that rely on understanding something systematically, thinking critically, solving problems, and making the right decisions (Katimi, 2021; Uyun et al., 2023). These abilities are an important basis for forming a generation ready to face real challenges in everyday life. As an integral part of science learning, scientific reasoning includes thinking logically and rationally, supported by a deep understanding of scientific concepts and applying information to produce decisions based on facts (Handayani

et al., 2020). Thus, science learning increases knowledge and forms a critical and responsible mindset in dealing with global issues, such as energy sustainability. This ability will help students think critically, reason scientifically, and make decisions in complex problems. Decision-making ability can be interpreted as a process to produce the right choice from choices by considering the various risks of the decisions made. In decision-making, several indicators will be involved, such as analyzing information, analyzing options, analyzing risks, and determining choices (Siagian et al., 2022; Tasyakuri & Faizah, 2024).

Decision-making will be a challenge for students because students need to reflect on the problems that occur, analyze relevant information, argue, apply reasoning skills, and apply these processes in decision-making. The decision-making process requires an in-depth analysis of the long-term impacts of the decisions made. Science education is a science related to nature. Students are invited to understand natural phenomena through a scientific approach, conduct experiments, and apply scientific methods in solving problems. This aims to teach students so that students can understand the relationship between science and everyday social life (Pratiwi, 2020). Science education is expected to develop students' reasoning and analytical skills based on scientific concepts and principles to solve problems. At the junior high school level, students are in a period of concrete thinking towards abstract thinking, so it is appropriate to combine concept-based learning with everyday life (Siregar, 2020).

Socio-scientific issues are social issues in society that are related to complex science, also involving other fields such as politics, economics, and ethics. This socio-scientific education is an approach that examines phenomena, facts, or events that are currently occurring in society based on social issues related to science (Bada, 2022; Sismawarni et al., 2020). By understanding the concepts of renewable energy, students learn about science and develop decision-making skills based on actual evidence, social values, and future impacts (Irawati et al., 2021). This will later prepare them to become more aware and responsible citizens in facing global challenges such as climate change and energy resource scarcity, and students can contribute to sustainable solution efforts.

The integration of Socio-scientific issues in the world of education is one of the significant developments in modern science. Socio-scientific issues, such as the energy crisis, climate change, or sustainability, provide an authentic context for students to understand scientific concepts more relevantly. However, its application in the education curriculum still faces various challenges (Yulianti et al., 2016). These challenges include limited learning resources, lack of teacher training, and the dominance of approaches that focus too much on theory without any connection to real-world problems. Knowledge of energy concepts, for example, is generally taught only in terms of conceptual knowledge. This approach often makes it difficult for students to understand the real impacts of energy use in everyday life. For example, students may be able to explain how energy is produced. Still, they lack an understanding of fossil-based power plants' ecological and social implications or the advantages and challenges of renewable energy. Therefore, schools must be able to provide more comprehensive and relevant insights, including an understanding of energy concepts and awareness of issues of the energy crisis, sustainability, and energy resource management (Hidayat & Abdillah, 2019).

Education that emphasizes the integration of these issues will create a young generation that is wise and critical in facing future energy challenges. They not only understand science but are also able to use it to provide solutions that are beneficial to society. This is in line with the vision of 21st-century education that emphasizes problem-based learning and higher-order thinking skills. These socio-scientific issues motivate students to think more deeply and encourage them to find innovative solutions to complex problems (Musliman & Damayanti, 2024). For example, when discussing the use of renewable energy, students can be encouraged to consider various factors such as construction costs, environmental impacts, and sustainability. In this case, they are invited to argue based on accurate data and evidence, for example, comparing the efficiency of solar panels with wind turbines or assessing the social impact of building hydroelectric power plants in rural areas. In addition, students also learn to collaborate and communicate effectively when finding solutions together.

Understanding socio-scientific issues, especially those related to renewable energy, is becoming increasingly crucial in modern education. Through this understanding, students are trained to think critically when dealing with real problems in the community. They will be faced with various environmental, social, and economic considerations, which require in-depth analysis before making decisions (Mahardika, 2023). Science is a scientific understanding related to a meaningful understanding of nature systematically, factually, and based on concepts and principles in everyday life. By integrating social issues into science learning, students will be better prepared to face the complexities of the real world, and students will be able to make decisions based on rational considerations.

According to Mardhiyana and Sejati (2016), integrating Socio-scientific issues in learning also helps students develop the ability to ask relevant questions, search for and evaluate information, and build arguments based on evidence. This process improves critical thinking skills and builds students' confidence in facing real-world challenges. Integrating socio-scientific issues in learning provides many benefits for students and society in general. First, this approach helps students understand the relationship between science and everyday life.

They learn about scientific concepts and how science can be applied to solve real problems. Second, education based on Socio-scientific issues increases students' awareness of environmental and social issues. Thus, they will be more concerned about sustainability and wiser in utilizing natural resources. Third, learning based on Socio-scientific issues also improves communication and collaboration skills. Students can discuss, exchange ideas, and work in teams to solve problems. Fourth, this approach encourages students to become lifelong learners who seek new information and solutions to face challenges that change over time. Despite its many benefits, implementing socio-scientific issue-based learning is not easy. One of the main challenges is teachers' lack of understanding of integrating these issues into learning. Many teachers find it difficult to design materials that are relevant and interesting to students (Fadhilla, 2021).

In addition, time constraints and a dense curriculum often become obstacles to implementing this approach effectively. To overcome these challenges, comprehensive teacher training is needed to understand and enforce socio-scientific issue-based learning. This training includes developing teaching materials, strategies, and learning evaluations. In addition, collaboration between schools, universities, and environmental organizations can also help provide the necessary resources and support. Technology can also support socio-scientific issue-based learning (Masykuri & Prayitno, 2024). For example, students can use the internet to search for information about energy issues or use online simulations to understand the impacts of various energy options. By utilizing technology, learning becomes more interactive and engaging for students. The purpose of providing problems related to socio-scientific issues is to describe social problems that are currently occurring in society related to scientific science. Also, providing information on these socio-scientific issues can guide students in improving their decision-making abilities. Making decisions yourself is very important because later, students will solve problems that are occurring daily (Pambudi et al., 2018). Socio-scientific issues in terms of energy are very appropriate to be integrated into the world of education because they can help students understand the relationship between science, society, and the environment in more depth and can encourage them to develop critical thinking skills and the ability to make decisions responsibly (Sulistina et al., 2024).

Combining student opinions from various perspectives and considering various factors is an important step for students in deciding the most appropriate solution (Ariadila et al., 2023). This decision-making process not only involves the ability to choose the best solution but also requires the ability to evaluate each alternative properly. Students need to consider the short-term and long-term impacts of each option and understand the consequences of the chosen option. Students must also be able to evaluate their decision-making process by reflecting on the underlying reasons for the decisions taken and how they can affect various parties. By reflecting on the steps that have been taken, students not only make decisions based on facts, but they will also develop more profound critical thinking skills. This ability will be helpful in academics and everyday life, where they will face situations that require rational considerations and are based on scientific knowledge (Pasolong, 2023; Trimahesri & Hardini, 2019). In addition, it will also foster an attitude of social responsibility, and they will be more sensitive to the needs of society and more ready to contribute and create sustainable solutions. So, finally, this ability will produce individuals who have intellectual abilities and increase concern for their surroundings and the common good. Based on the background that has been described, this study aims to determine the level of students' ability to make decisions related to sustainable energy issues. This study needs to be conducted to create a young generation aware of the importance of protecting the environment and preserving natural resources so that they are not damaged and maintain the sustainability of the ecosystem. This awareness includes a deep understanding of the negative impacts of the use of fossil fuels and a sustainable lifestyle to support the balance of nature. This study is expected to be a reference for developing better education and assist in developing more effective learning methods to train critical thinking skills so that students can face socio-scientific problems around them well.

METHODS

The method used in this study is quantitative research with a cross-sectional survey research design. Cross-sectional design is a type of research design that aims to collect data in the field from subjects at only one point in time. Then, the data obtained can be analyzed using statistical, mathematical, or computational techniques (Priadana & Denok, 2021). This method aims to obtain actual data and is based on real problems. In this study, researchers collected data to measure students' reasoning and decision-making abilities related to sustainable energy issues. This test takes approximately two teaching hours, where students are asked to solve several problems presented in the questions. This period is designed to allow students to answer in-depth and describe their thinking patterns as a whole. The research sample was determined using the purposive sampling technique, a sample selection method where researchers intentionally take specific samples in a population to be studied (Fauzy, 2019). This study's population was all SMPN 1 Sambit Ponorogo class VII students. From this population, class VII B was selected as a research sample with a sample size of 26 students. This sample was selected based on specific considerations, such as consideration of time, access, and student

characteristics relevant to the study's needs, such as age, level of understanding, and initial abilities deemed relevant. By choosing this class, researchers hope to minimize the possibility of bias and increase the validity of the research results.

This research, which measured reasoning and decision-making ability related to sustainable energy issues, gave students test questions into two stages. In the first test, the questions were worked on by all samples, and the second test was only done by the sample with the highest score in the previous test. The first test questions consisted of 8 multiple-choice items, each arranged based on decision-making ability indicators: Analyzing information, identifying options, analyzing risks, and making choices, with each item having four answer choices with one correct answer and three distractor answers. The second test consisted of one essay question based on real problems related to sustainable energy. In this second test, students were asked to choose the available options by including reasons and considering the advantages and disadvantages of each option chosen.

Data analysis to measure students' decision-making ability was carried out using the Rasch model assisted by the Ministep Rasch application (a mini version of Winstep Rasch that can only measure for limited respondents of 25-75 respondents). This Rasch model can analyze the relationship between respondents and question items. The data that has been collected will then be analyzed using the RASCH Model using Ministep Rasch software. Initially, the data obtained will be tabulated, or the data will be presented as a table in Microsoft Excel, which will then be converted and analyzed with the help of Ministep Rasch Software. The results of data analysis carried out using the RASCH model include several things, including Item Analysis, Respondent and Instrument Reliability Analysis, and the last is instrument validity analysis.

RESULT AND DISCUSSION

This item analysis is done by analyzing the item measure. This item measure is the level of difficulty of the question items created. This step is done to find out which items respondents most agree upon. The highest logit value means the question item is challenging for respondents to agree to, and the lowest is the opposite (Radja et al., 2023). Based on Table 2, it is known that the Standard Deviation value in the item shows a value of 0.27. So that it can be categorized as the level of suitability of the question items as follows.

Table 1. Item Difficulty Level

Category	Interval
Very Difficult	≥ 0.27
Difficult	0.27 - 0.0
Easy	0.0 - -0.27
Very easy	≤ -0.27

Table 2. Level of difficulty

ITEM STATISTICS: MEASURE ORDER													
ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	ZSTD	OUTFIT MNSQ	ZSTD	PTMEASUR-AL CORR.	EXP.	OBS%	MATCH EXP%	ITEM
3	76	26	.35	.24	1.29	1.14	1.26	1.00	.58	.61	23.8	36.9	P3
2	78	26	.23	.24	.68	-1.33	.70	-1.12	.64	.58	47.6	38.5	P2
7	79	26	.17	.25	1.09	.44	1.03	.19	.57	.57	38.1	38.6	P7
1	81	26	.05	.25	.91	-.25	.91	-.20	.53	.55	52.4	40.0	P1
8	82	26	-.02	.25	1.19	.76	1.09	.40	.53	.54	33.3	44.4	P8
4	83	26	-.08	.26	.87	-.39	.79	-.63	.57	.53	61.9	44.8	P4
5	83	26	-.08	.26	.73	-.99	.76	-.77	.58	.53	52.4	44.8	P5
6	90	26	-.60	.29	1.24	.76	1.18	.58	.37	.44	42.9	48.3	P6
MEAN	81.5	26.0	.00	.25	1.00	.02	.97	-.07			44.0	42.1	
P.SD	4.0	.0	.27	.02	.22	.84	.19	.69			11.4	3.8	

Based on Table 2, the test items' difficulty levels can be sorted from the most difficult to the easiest. It is known that test item number 3 is included in the category of the most challenging test items with a value of 0.35. The difficult category contains three items: questions number 2, 7, and 1. The last one is included in the easy category, and there are four questions, namely numbers 8, 4, 5, and 6. Table 3 shows that the number of respondents was 26 students, and the number of test items was 8 (multiple choice). The data information above shows the interaction between *personal reliability* and *item reliability*. Reliability assesses the extent to which the results of a measurement can be trusted, which is intended to analyze whether this decision-making ability

instrument can be used generally (Maulidya et al., 2023). *Person Measure* displays the average score of all respondents who completed the student decision-making ability assessment instrument. According to Bond et al., the Cronbach Alpha reliability value has four categories, namely the "Very Good" category of 0.80 to 1.00, the "Good" category is worth 0.70 to 0.80, the "Fair" category is worth 0.60 to 0.70, and the "Poor" category is worth 0.00 to 0.60 (Salsabila, 2023). The table above shows the Cronbach Alpha value in the form of interaction between person and item items as a whole, which is 0.72, a "Good" level. Then, it shows the *person reliability* or respondent reliability value of 0.65 and *item reliability* or instrument reliability of 0.10. This shows that the consistency of respondents' answers is in the "good" category. So, it can be concluded that the test to measure decision-making ability shows that the consistency of students' answers is in a good category (Azizah & Wahyuningsih, 2020).

Table 2. Reliability of respondents and instruments

SUMMARY OF 26 MEASURED (EXTREME AND NON-EXTREME) PERSON									
	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	ZSTD	OUTFIT MNSQ	ZSTD	
MEAN	25.1	8.0	1.21	.70					
SEM	.9	.0	.30	.11					
P.SD	4.5	.0	1.51	.56					
S.SD	4.6	.0	1.54	.57					
MAX.	32.0	8.0	4.10	1.84					
MIN.	17.0	8.0	-.46	.37					
REAL RMSE	.91	TRUE SD	1.21	SEPARATION	1.33	PERSON RELIABILITY	.64		
MODEL RMSE	.90	TRUE SD	1.21	SEPARATION	1.35	PERSON RELIABILITY	.65		
S.E. OF PERSON MEAN	.30								
PERSON RAW SCORE-TO-MEASURE CORRELATION = .94									
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .72 SEM = 2.36									
STANDARDIZED (50 ITEM) RELIABILITY = .92									
SUMMARY OF 8 MEASURED (NON-EXTREME) ITEM									
	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	ZSTD	OUTFIT MNSQ	ZSTD	
MEAN	81.5	26.0	.00	.25	1.00	.02	.97	-.07	
SEM	1.5	.0	.10	.01	.08	.32	.07	.26	
P.SD	4.0	.0	.27	.02	.22	.84	.19	.69	
S.SD	4.2	.0	.29	.02	.23	.90	.21	.73	
MAX.	90.0	26.0	.35	.29	1.29	1.14	1.26	1.00	
MIN.	76.0	26.0	-.60	.24	.68	-1.33	.70	-1.12	
REAL RMSE	.27	TRUE SD	.02	SEPARATION	.08	ITEM RELIABILITY	.01		
MODEL RMSE	.26	TRUE SD	.09	SEPARATION	.33	ITEM RELIABILITY	.10		
S.E. OF ITEM MEAN	.10								
ITEM RAW SCORE-TO-MEASURE CORRELATION = -1.00									
Global statistics: please see Table 44.									
UMEAN=.0000 USCALE=1.0000									

Table 3. Raw Residual

Table of RAW RESIDUAL variance in Eigenvalue units			
	Eigenvalue	Observed	Expected
Total raw variance in observations =	10.2622	100.0%	100.0%
Raw variance explained by measures =	2.2622	22.0%	21.6%
Raw variance explained by persons =	.8749	8.5%	8.3%
Raw Variance explained by items =	1.3873	13.5%	13.2%
Raw unexplained variance (total) =	8.0000	78.0%	78.4%
Unexplned variance in 1st contrast =	2.2482	21.9%	28.1%
Unexplned variance in 2nd contrast =	1.8753	18.3%	23.4%
Unexplned variance in 3rd contrast =	1.2087	11.8%	15.1%
Unexplned variance in 4th contrast =	1.0692	10.4%	13.4%
Unexplned variance in 5th contrast =	.6603	6.4%	8.3%
Essential Unidimensionality (Rasch/Common variance) = 35.4%			

Validity assesses the extent to which a measuring instrument is accurate and precise in performing its measuring function (Alavi et al., 2020). The validity of this instrument functions to assess the test instrument for students' decision-making abilities related to energy problems. Table 4 shows the validity of the multiple-choice questions created to measure students' decision-making abilities. From the data above, it is known that the *Raw variance explained by measures value* shows a value of 22%. This is the requirement for the validity of the instrument items. If the *Raw variance explained by measures score* > 20% is said to be Fulfilled, the score > 40% is said to be Good, and the score > 60% is said to be Special. So, it can be concluded that the questions created to measure students' decision-making abilities are in the Fulfilled category (Fitri, 2017). Based on the following Figure 1, it is known that most students (above the red mark) can make good decisions based on the instruments that have been given. However, some students (below the red mark) still cannot make good

decisions based on the instruments that have been given (Salsabila, 2023).

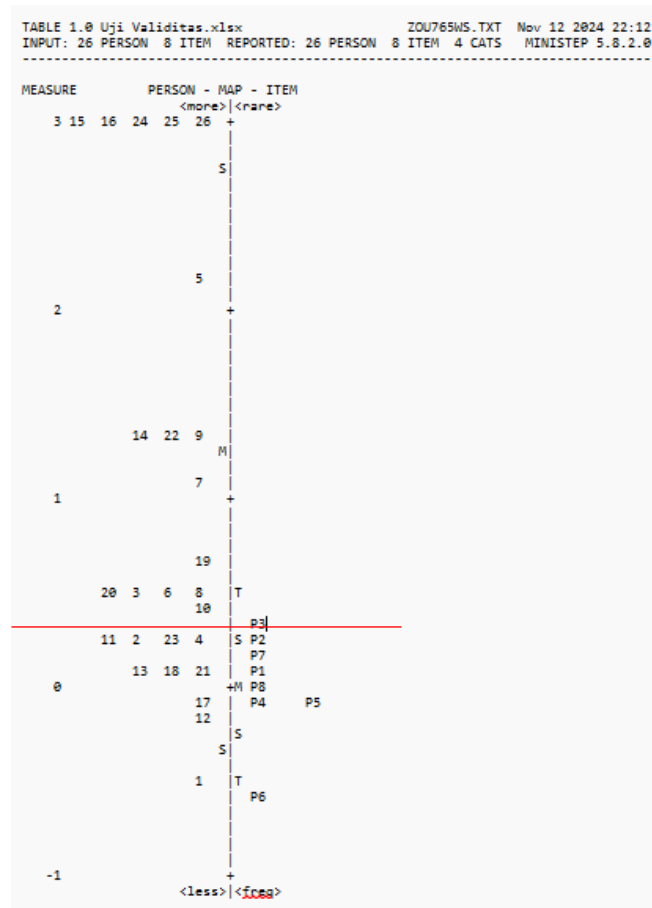


Figure 1. Peta Wrigt Map Person-Item

The next test is one essay test question about energy problems. For this test, subjects are selected based on the highest score from the previous test. Students are then given one essay question, from which students are asked to make the correct answer. The students' answers will later be analyzed to determine the extent of the student's ability to make decisions. The questions are as follows.

"In Antarctica, melting has been accelerating in recent years. This is due to rising global temperatures, which are causing ice to flow into the ocean. Melting ice in Antarctica can lead to rising sea levels, impacting small islands and coastal areas worldwide. Scientists have proposed several options to address this problem, such as

1. *Reducing greenhouse gas emissions,*
2. *Developing carbon capture technologies*
3. *Accelerating research on adaptation to climate change.*

Based on the case of melting ice in Antarctica, choose and analyze the options proposed by scientists! The students' answers are as follows:

"Reducing greenhouse gas emissions and developing carbon capture technology" (Ananda Putra, VII B)

Ananda identified that the problem of melting ice in Antarctica can be solved by reducing greenhouse gas emissions and developing carbon capture technology. The selection of both options is good. However, he did not identify the solution for strong reasons. In addition, Ananda has not compared the advantages and disadvantages of the options mentioned, so the selection of the best solution cannot be optimized based on the context and impact produced. So, Ananda's answer does not provide an in-depth exploration of the various solution options available. Ananda's ability to make decisions still needs to be improved. Ananda needs to explain why the solution was chosen by mentioning the advantages, disadvantages, and risks of choosing a sustainable life. Almost similar to Ananda's answer, namely the answer from Alifiya Widya:

"I think it is necessary to accelerate research on adaptation to climate change because it will be faster..."
(Alifiya Widya, VII B)

Alifiya's answer shows that she proposed accelerating research on climate change adaptation. This shows that she is aware of the importance of adaptation efforts as a response to the impacts of climate change that cause melting ice in the Antarctic. However, Alifiya only mentioned the Solution without mentioning the advantages and disadvantages of the Solution that has been given. Then the reason "because it is faster ..." does not provide a strong and in-depth reason. So, Alifiya's answer above still does not reflect a deep exploration of decision-making ability. Similar to the answers from Abimanyu and Novi, they both answered with the following answers:

"Reducing greenhouse gas emissions" (Abimanyu & Novi, VII B)

The answers from Abimanyu and Novi show that it is important to reduce greenhouse gas emissions to reduce ice melting in Antarctica. However, the answers from both students are still less specific and are not accompanied by in-depth reasons. They did not explain examples of reducing greenhouse gas emissions, such as using renewable energy, energy efficiency, or reforestation. They also did not mention the advantages and disadvantages of the proposed Solution. This shows that Abimanyu and Novi's ability to explore, analyze, and detail the Solution to a problem still needs to be improved to make the right Decision. The answer from Cahya Wahyu is as follows:

"Reducing greenhouse gas emissions, so that the gas does not explode the glass." (Cahya, VII B)

Cahya's answer shows a solution by reducing greenhouse gas emissions, but Cahya shows an unscientific reason: "so that the gas does not explode the glass." The term greenhouse gas does not refer to gases that can explode glass, but rather to gases such as carbon dioxide, carbon monoxide, or methane that are trapped in the earth's atmosphere so that they can cause global warming and melting ice in the Antarctic (Siburian & Efriza, 2020). Although Cahya mentioned a fairly relevant solution, he has not explained how emission reductions can be carried out, such as using renewable energy, energy efficiency, or reforestation. This misunderstanding of the concept of greenhouse gases requires follow-up to improve further scientific understanding and the ability to provide more in-depth decisions based on scientific knowledge.

The results of this study indicate that in the first test, some students could make the right decisions related to sustainable energy issues based on. The use of instruments specially created to evaluate students' reasoning and decision-making abilities showed promising results with a Cronbach Alpha value in the form of interaction between person and item items as a whole, which was 0.72, a "Good" level. Then, it showed a person reliability value or respondent reliability of 0.65 and item reliability or instrument reliability of 0.10. This shows that the consistency of respondents' answers is in the "good" category. Thus, this study can provide direction for further development in designing instruments and more effective learning approaches to improve students' abilities in dealing with complex issues (Fang et al., 2019).

In the second test, some students identified the importance of reducing greenhouse gas emissions, developing carbon capture technology, or adapting research to solve the melting ice problem in Antarctica. This shows that students have a good initial understanding and are also aware of a problem relevant to sustainable energy. However, although they have chosen a solution to the sustainable energy problem, their answers are generally not in-depth. Students have not been able to provide strong reasons, explore the advantages and disadvantages of each solution, or provide concrete examples of implementing the proposed solution. Some answers also show scientific misconceptions, as seen in the understanding of greenhouse gases. This shows that students' ability to analyze problems, evaluate various options, and make decisions based on scientific knowledge still needs to be improved through more profound and focused learning. However, the results of this test show good potential for more profound development by integrating socio-scientific issues into learning activities to help students think critically and practice their ability to make decisions scientifically.

CONCLUSION

Based on research data to measure students' decision-making ability related to energy problems. The difficulty level of the question items from the most difficult to the easiest accepted by respondents shows that question item number 3 is included in the category of the most challenging question items with a value of 0.35. The difficult category contains three items, namely questions number 2, 7, and 1. The last one is included in the easy category, and there are four questions, namely numbers 8, 4, 5, and 6. The instrument regarding

energy problems has been made valid with a category (fulfilled) with a *Person Reliability value* of 0.65, which proves that the consistency of students' answers is good. Most students have been able to make good decisions based on the instruments that have been given. However, there are still some students who are still unable to make good decisions based on the instruments that have been given. For the essay test, most students already understand the importance of solutions to the problem of melting ice in the Antarctic, but their answers are not in-depth and are not accompanied by decisive reasons, advantages, disadvantages, or examples of implementation. However, this study shows that students already have a good initial understanding and awareness of a problem relevant to the issue of sustainable energy. The results of this study also show good potential for more profound development by integrating socio-scientific issues in learning activities to help students think critically and train their ability to make scientific decisions.

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