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Identifying Energy Literacy Understanding of Physics Teacher Candidate Students Using a Four-Tier Test Instrument Based on Energy Literacy

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ABSTRACT: This research aims to identify the energy literacy abilities of prospective physics teacher students using a test instrument in the form of a four tier test. This type of research is quantitative descriptive research. The population of this study was one class of prospective physics teacher students at the first level, totalling 30 students. The data collection technique was carried out using a test technique using a test instrument in the form of a four-tier test with a total of 40 questions. The four-tier test has the advantage of being able to capture more accurate information with diverse answer patterns, which is one of the reasons for its use. The analysis technique in this research is descriptive statistical analysis. The level of understanding of students' energy literacy is categorized into three categories, namely understanding, not understanding, and misunderstanding. The energy literacy indicators measured in this research consist of six indicators which include: (1) basic energy knowledge; (2) understanding energy sources and their relationships; (3) awareness of the importance of energy use for individuals and social life; (4) knowing trends in energy use in Indonesia and global energy sources-supply and use; (5) understand the influence of the development of energy sources and the implementation of their use in society; and (6) understand the influence of the development of energy sources and their use on the environment. The research results show that the level of understanding of energy literacy among students is in the category of not understanding as much as 5.83% of students. Furthermore, the level of understanding of students' energy literacy in the understanding category was 31.38% of students. Meanwhile, there were 62.79% of students who had a level of understanding of energy literacy in the misunderstanding category.

KEYWORDS: Level of student understanding, energy literacy, energy literacy indicators, answer patterns.

I. INTRODUCTION

Energy is an important concept in physics so that citizens can make the right decisions regarding important social issues such as energy production and use and climate change (Chinnappan, 2015; Nieminen et al., 2017). Energy is a key issue for sustainable development which is also the responsibility of science education (Wellington, 2003). This problems was because education has the potential to change the behaviour of young adults to use energy rationally and increase energy literacy (Zografakis et al., 2008). Therefore, science education has an important role to play in preparing young adults from an early age to become future decision makers regarding energy (Lee Su Han & Park Jong Won, 2013).

Energy literacy can be defined as an understanding of the nature and role of energy in the world and everyday life. Apart from that, energy literacy also comes with the ability to apply this understanding to answer challenges and solve energy-related problems. The characteristics of individuals who have energy literacy are (a) being able to track energy flows and think in terms of energy systems; (b) know the amount of energy used, purpose and energy sources; (c) able to assess the credibility of energy-related information; (d) able to communicate about energy and energy use in a meaningful way; (e) able to make decisions regarding energy and its consequences; and (f) continue to learn about energy throughout his life (J. E. DeWaters & Powers, 2011; J. DeWaters & Powers, 2013).

Prospective physics teacher students are today's citizens who have personal responsibility in terms of energy use. In addition, in the future they are teachers who have the responsibility to teach energy concepts to students. Teachers play a key role in improving students' conditions (McDermott et al., 2006). It is important for prospective physics teacher students to have energy literacy so that in the future they can grow and develop their students' energy literacy. With their energy literacy, teachers are expected to become the main agents who can reorient education so that it can bring change towards a sustainable world (Stephens et al., 2008).

Identifying Energy Literacy Understanding of Physics Teacher Candidate Students Using a Four-Tier Test Instrument Based on Energy Literacy

Identifying energy literacy among prospective physics teacher students is important for at least two reasons. First, the identification results will inform the state of energy literacy of the respondents being measured. Second, the identification results provide data to make the right decisions (Yusup et al., 2017). To obtain data about the energy literacy of prospective physics teachers, measurement instruments are needed. There are a number of test instruments that have been developed to measure energy literacy. However, based on the results of previous research studies, the most effective and efficient form of test for exploring students' energy literacy is a four tier test. Some of the advantages of this form of test are that it can explore in depth and detail students' thought processes through scientifically given answer patterns (Gurel et al., 2015; Kaltakci-Gurel et al., 2017). Assessments related to energy literacy have not been carried out so far. In identifying students' understanding of energy literacy, there are several indicators that are determined related to energy literacy. The following are the energy literacy indicators studied in this research.

Table 1. Indicators of Literacy Energy

No.	Indicators of Literacy Energy
1.	Basic energy knowledge
2.	Understanding energy sources and their relationships
3.	Concerning about the importance of energy use for individuals and for social life
4.	Understanding trends in energy use in Indonesia and global energy sources-supply and use
5.	Understanding the influence of the development of energy sources and the implementation of their use in society
6.	Understanding the impact of the development of energy sources and their use on the environment

Based on the explanation of the problem and a review of several previous research results, this research is focused on identifying the energy literacy understanding of prospective physics teacher students using a four-tier test instrument.

II. METHOD

This research is a type of survey research with a quantitative descriptive type (Sugiyono, 2010). Based on this type of research, the test is given once to identify the level of understanding of Energy Literacy. The population of this study were prospective physics teacher students. The research sample was first level prospective teacher students obtained through purposive sampling technique. In this research, the number of samples involved was 30 prospective physics teacher students.

The research instrument is an Energy Literacy understanding test in the form of a Four Tier Test. Data collection techniques were carried out using test techniques. The aim of this research is to identify the energy literacy understanding of prospective physics teacher students. For this reason, the analysis technique used in this research is descriptive statistics. The descriptive statistical analysis is in the form of average, standard deviation, frequency and percentage. The level of understanding of students' energy literacy is measured based on student answer patterns (Kaltakci-Gurel et al., 2017; Nurjani et al., 2020; Rahmawati et al., 2021; Sheftyawan et al., 2018). Table 2 shows the categorization of possible levels of understanding regarding the interpretation patterns of student answers.

Table 2. Categorization of Energy Literacy Understanding Levels based on Answer Patterns

No.	Answer	Confidence Level	Reason	Confidence Level	Answer Patterns	Categorization
1	True	High	True	High	b-sy-b-sy	Understand
					b-sy-b-y	
					b-y-b-sy	
					b-y-b-y	
2	True	High	True	Low	b-sy-b-t	Not understand
					b-sy-b-m	
					b-y-b-t	
					b-y-b-m	
3	True	Low	True	High	b-t-b-sy	
					b-t-b-y	
					b-m-b-sy	
					b-m-b-y	
4	True	Low	True	Low	b-t-b-t	
					b-t-b-m	
					b-m-b-t	
					b-m-b-m	
5	True	High	False	Low	b-sy-s-t	

No.	Answer	Confidence Level	Reason	Confidence Level	Answer Patterns	Categorization
					b-sy-s-m	
					b-y-s-t	
					b-y-s-m	
6	True	Low	False	Low	b-t-s-t	
					b-t-s-m	
					b-m-s-t	
					b-m-s-m	
7	False	Low	True	High	s-t-b-sy	
					s-t-b-y	
					s-m-b-sy	
					s-m-b-y	
8	False	Low	True	Low	s-t-b-t	
					s-t-b-m	
					s-m-b-t	
					s-m-b-m	
9	False	Low	False	Low	s-t-s-t	
					s-t-s-m	
					s-m-s-t	
					s-m-s-m	
10	True	High	False	High	b-sy-s-sy	Misconception
					b-sy-s-y	
					b-y-s-sy	
					b-y-s-y	
11	True	Low	False	High	b-t-s-sy	
					b-t-s-y	
					b-m-s-sy	
					b-m-s-y	
12	False	High	True	High	s-sy-b-sy	
					s-sy-b-y	
					s-y-b-sy	
					s-y-b-y	
13	False	High	True	Low	s-sy-b-t	
					s-sy-b-m	
					s-y-b-t	
					s-y-b-m	
14	False	High	False	Low	s-sy-s-t	
					s-sy-s-m	
					s-y-s-t	
					s-y-s-m	
15	False	High	False	High	s-sy-s-sy	
					s-sy-s-y	
					s-y-s-sy	
					s-y-s-y	
16	False	Low	False	High	s-t-s-sy	
					s-t-s-y	
					s-m-s-sy	
					s-m-s-y	

The scoring rubric for categorization of students' level of understanding of Energy Literacy is prepared based on the pattern of answers given by students which is shown in Table 3 (Deratama et al., 2022; Kuo et al., 2015; Panadero & Jonsson, 2013).

Table 3. Comprehension Scoring Rubric based on Answer Patterns

No.	Categorization of Answer	Answer Pattern	Score
1	Answers and reasons are correct with a high level of confidence in the answer choices and reasons	b-sy-b-sy	3
		b-sy-b-y	
		b-y-b-sy	
		b-y-b-y	
2	Answers and reasons are correct with a low level of confidence in answer choices and reasons	b-sy-b-t	2
		b-sy-b-m	
		b-y-b-t	
		b-y-b-m	
		b-t-b-sy	
		b-t-b-y	
		b-t-b-t	
		b-t-b-m	
		b-m-b-sy	
		b-m-b-y	
		b-m-b-t	
		b-m-b-m	
3	True answer, false reason	b-sy-s-sy	1
		b-sy-s-y	
		b-sy-s-t	
		b-sy-s-m	
		b-y-s-sy	
		b-y-s-y	
		b-y-s-t	
		b-y-s-m	
		b-t-s-sy	
		b-t-s-y	
		b-t-s-t	
		b-t-s-m	
		b-m-s-sy	
		b-m-s-y	
		b-m-s-t	
		b-m-s-m	
4	False answer, true answer	s-sy-b-sy	1
		s-sy-b-y	
		s-sy-b-t	
		s-sy-b-m	
		s-y-b-sy	
		s-y-b-y	
		s-y-b-t	

No.	Categorization of Answer	Answer Pattern	Score
		s-y-b-m	
		s-t-b-sy	
		s-t-b-y	
		s-t-b-t	
		s-t-b-m	
		s-m-b-sy	
		s-m-b-y	
		s-m-b-t	
		s-m-b-m	
5	Answer and reason is false	s-sy-s-sy	0
		s-sy-s-y	
		s-sy-s-t	
		s-sy-s-m	
		s-y-s-sy	
		s-y-s-y	
		s-y-s-t	
		s-y-s-m	
		s-t-s-sy	
		s-t-s-y	
		s-t-s-t	
		s-t-s-m	
		s-m-s-sy	
		s-m-s-y	
		s-m-s-t	
		s-m-s-m	

III. RESULT AND DISCUSSION

A recapitulation of data from the energy literacy understanding test results for prospective physics teacher students is shown in Table 4. Table 4 shows that the highest percentage of conceptual errors is in the LE 6 indicator. Meanwhile, the lowest percentages for the category of incorrect concepts are in the LE 1 indicator, LE 3 indicator, and LE indicator 4.

Table 4. Descriptive Statistics and Categorization of Energy Literacy Understanding

Indicators of Literacy energy	*N*	*M*	*SD*	Categorization of understanding (%)		
				Understand	Not understand	Misconception
LE 1	30	0,97	0,85	43,33	0	56,67
LE 2	30	0,83	0,70	33,33	0	66,67
LE 3	30	0,10	0,31	33,33	10,00	56,67
LE 4	30	0,37	0,56	36,66	6,67	56,67
LE 5	30	0,50	0,57	25,00	15,00	60,00
LE 6	30	0,83	0,70	16,67	3,33	80,00
Mean	30	2,77	1,70	31,38	5,83	62,79

Notes:

LE 1: Basic knowledge of energy; LE 2: Understanding energy sources and their relationships; LE 3: Concern about the importance of energy use for individuals and for social life; LE 4: Understand energy use trends in Indonesia and global energy sources supply and use; LE 5: Understand the impact of developing energy sources and implementing their use in society; LE 6: Understand the impact of the development of energy sources and their use on the environment.

The highest percentage for the category of not understanding the concept is in the L5 indicator (15%). Meanwhile, the lowest percentage for the category of not understanding the concept was in the LE 1 and LE 2 indicators (0% each). The concept understanding category with the highest percentage is in the LE 1 indicator (43.33%). Meanwhile, the lowest percentage was in the

LE 6 indicator (16.67%). Based on the analysis of the average percentage of energy literacy understanding levels, the highest percentage was in the wrong concept category (62.79%) and the lowest percentage was in the not understanding the concept category (5.83%).The data above shows that the percentage of students understanding the influence of the development of energy sources and their use on the environment is still low. This is indicated by a percentage value of only 16.67%. Meanwhile, the energy literacy indicator with the highest percentage level of understanding is an indicator related to basic energy knowledge. Furthermore, the category of conceptual error rate with the highest percentage is an indicator of understanding the influence of the development of energy sources and their use on the environment (80%). Meanwhile, the energy literacy indicators with the lowest percentage are basic energy knowledge, awareness of the importance of energy use for individuals and for social life, and knowledge related to trends in energy use in Indonesia and global energy sources, supply and use. The findings of this research are that the energy literacy of prospective physics teacher students with the highest percentage is in the category of misunderstanding the concept (62.79%), followed by the category of understanding the concept (31.38%), and the category of not understanding the concept (5.83%). Based on the research findings, it can be concluded that the level of understanding of energy literacy among prospective physics teacher students is generally still low.The average score (M) and standard deviation (SD) data are also shown in Table 4. The average score is in the LE 1 indicator. This data shows that the dominant students have high abilities in energy literacy related to basic energy knowledge. Meanwhile, the lowest average score is on the LE 3 indicator, namely concern about the importance of energy use for individuals and for social life.The low level of understanding of energy literacy among prospective physics teacher students shows that prospective physics teacher students are not yet accustomed to receiving material about energy and applying energy knowledge to solve problems in everyday life. In addition, a person's level of understanding of energy literacy shows individual characteristics regarding energy awareness. The characteristics of individuals who have energy literacy can be seen from several things, namely: (1) having a basic understanding of how energy is used in everyday life; (2) have an understanding of the impact of energy production and consumption on all areas of the environment and society; (3) sensitive to the importance of energy conservation and the need to develop alternative energy resources based on fossil energy sources; (4) be aware of the impact of personal decisions and actions related to energy on society; and (5) strive to make choices and decisions that reflect attitudes related to energy resource development and energy consumption (J. E. DeWaters & Powers, 2011; J. DeWaters & Powers, 2013; Jumrodah et al., 2021).

Similar previous research results regarding the characteristics of individuals who have energy literacy reveal that individuals who have energy literacy are individuals who have several characteristics. The characteristics referred to in this case are: (1) able to track energy flows and think in terms of energy systems; (2) understand how energy is used in everyday life; (3) able to assess the credibility of information about energy; (4) able to communicate about energy and energy use in a meaningful way; (5) able to make decisions based on knowledge about energy and energy use and take action based on an understanding of the impacts and consequences; (6) understand the impact of energy production and consumption on all areas of the environment and society; and (7) realizing the need for energy conservation and the need to develop renewable energy sources; and (8) individuals who continue to learn about energy throughout their lives (Aguirre-Bielschowsky et al., 2017; Chen et al., 2015; J. E. DeWaters & Powers, 2011; Martín-Gámez & Erduran, 2018; Yusup et al., 2017).

IV. CONCLUSIONS

Based on the research results, it can be concluded that the dominant level of understanding of energy literacy among prospective physics teacher students is still in the low category. Apart from that, the highest percentage of energy literacy understanding of prospective physics teacher students was in the wrong concept category (62.79%) and the lowest was in the category of not understanding the concept.

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