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Energy Literacy Profile of Vocational High School Teacher Candidates for Renewable Energy Engineering Expertise Program

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ABSTRACT

This study examines the energy literacy profile of engineering students as vocational high school teacher candidates for renewable energy engineering expertise programs in terms of 3 energy literacy domains: knowledge, attitudes, and behavior. This research uses a quantitative approach with a descriptive-comparative design, conducted on 135 engineering students from 3 study programs at the Indonesian University of Education. The results obtained are that the energy literacy knowledge of engineering students as vocational high school teacher candidates for renewable energy engineering expertise programs is low. Still, their energy literacy attitudes and behaviors are quite good. There was no statistically significant difference in energy literacy between the female and male student groups. In this study, it was known that students from 3 study programs received energy content from different courses. Their energy literacy results were influenced by differences in the range and depth of energy content provided by each study program. The results of this study can be a consideration for universities to develop energy literacy education and learning models and pay attention to the needs, content, and depth of energy content in each study program, especially study programs that are qualified as teachers candidates of vocational high school Renewable Energy Engineering Expertise Program.

Keywords: *Energy Education, Energy Literacy, Vocational High School Teacher Candidates*

INTRODUCTION

One of the factors for the failure of the implementation of the energy transition in almost every country, especially developing countries, is low public awareness (Assali et al., 2019; Guven and Sulun, 2017; Kacan, 2015; Ocetkiewicz et al., 2017; Qazi et al., 2019). Therefore, the involvement of the education sector is important to increase knowledge and concern and even change people's habits to support energy transition policies (Fuchs, 2012; Malkki and Alanne, 2017). The involvement of the education sector in the energy transition agenda is aimed at increasing people's energy awareness and literacy (IRENA, 2020). The role of energy education includes: (1) As a means of promoting and educating renewable energy to the community, as well as providing functional knowledge and understanding of the facts, concepts, and principles of renewable energy resources and technologies (IRENA, 2020; Kandpal and Broman, 2014), (2) As a driver of

public awareness towards the use of renewable energy resources and technology (Tabassum and Yasmin, 2017).

In a document published by UNESCO-UNEVOC (2017), the involvement of the TVET sector in responding to the global energy transition agenda is to improve education and increase awareness and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning. The document also states that for this goal to be realized, the TVET institution has the task of educating and training individuals to have: (1) Technical knowledge for the application of energy efficiency measures, (2) Technical knowledge for the application of renewable energy technologies, (3) Upskilling for emerging energy markets. The involvement of the education sector that has been mentioned earlier, namely to increase public energy awareness and literacy. Where in concept, the energy literacy framework consists of 3 domains.

DeWaters et al. (2007) developed an energy literacy framework covering the cognitive domain (conceptual knowledge or understanding and skills), the affective domain (sensitivity/attitude, personal responsibility), and the behavioral domain (active engagement). The characteristics of individuals who have energy literacy are also described by DeWaters and Powers (2013). They describe an individual who has energy literacy as one who: (1) Has a basic understanding of how energy is used in everyday life; (2) Has 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 energy-related decisions and actions on society; and (5) Seek to make choices and decisions that reflect attitudes related to the development of energy resources and energy consumption.

Many studies have been conducted related to energy literacy, including measurements of energy literacy of high school students in Taiwan (S. J. Chen et al., 2015; Lee et al., 2015) and measurement of literacy of high school students in the United States (Dewaters and Powers, 2011), measurement of energy literacy of people in Switzerland (Blasch et al., 2017), measurement of energy literacy of students in Portugal (Cotton et al., 2016), measurement of energy literacy of parents of students (Kacan, 2015), and teachers candidate (Guven and Sulun, 2017). The majority of the findings are that energy literacy is still low in knowledge, respondents also have a weak commitment to energy conservation activities, and show less attention to energy availability. The same is true in Switzerland and Finland; the listed energy literacy rates are low (Blasch et al., 2018; Kalmi et al., 2017). Zhang and Zhang (2020) examined the energy literacy of farmers residing in rural areas that were used as tourism destinations. It was found that there was no correlation between energy knowledge and the behavior shown. In several studies, a person's energy literacy is associated with gender, age, educational background, place of residence, etc. The majority of the results of the study stated that energy literacy and gender did not have a significant relationship (Dewaters and Powers,

2011; DeWaters and Powers, 2013; Fang et al., 2021; Lee et al., 2015; Martins et al., 2020). While the relationship between energy literacy to educational background factors, according to Blasch et al. (2019), suggests a positive correlation exists between an individual's level of education and energy literacy. In their research, Mills and Schleich (2012) also found that a person with a bachelor's degree is indicated to have better energy knowledge than someone who graduated from vocational high school. These results are also supported by Yeh et al. (2017), which link parents' educational background with children's literacy level. The results show that the higher the educational background of parents, the higher the child's literacy.

The reason for the importance of the study of energy literacy is that the informed and energy-literate public is more likely to be involved in the decision-making process, and will be better prepared to make wise and responsible energy-related decisions, choices, and actions (DeWaters et al., 2007). In a document published by UNESCO-UNEVOC (2017), one of the stages of implementing sustainable development in the TVET sector is to increase awareness, motivation,d energy literacy in all academic communities. So universities as educational institutions producing vocational teacher candidates, are responsible for preparing their students to have good energy literacy. Because later, they will carry out the task and responsibility to teach and educate according to the learning outcomes of vocational high school renewable energy engineering expertise program, instill the concept of energy literacy, and prepare students to have technical knowledge and skills, sensitivity and awareness, as well as be wise and responsible in using energy.

Therefore, vocational teacher candidates must have good energy literacy before becoming real teachers who will carry out these responsibilities. Supported by previous research reviews, no in-depth study has discussed energy literacy in vocational high school teacher candidates. Then in this study, the author will discuss the profile of energy literacy in engineering students who are qualified as a teacher in vocational high school renewable energy engineering expertise programs. In more detail, this study aims to (1) describe the energy literacy conditions of engineering students as vocational high school teacher candidates based on the domain of knowledge, attitudes, and behaviors, (2) Knowing the differences in energy literacy of engineering students as vocational high school teacher candidates based on gender group and origin of the study program.

METHOD

Based on the spectrum of vocational high schools in Indonesia, there is a special expertise program about energy, namely the Renewable Energy Engineering expertise program. Based on the circular letter on academic qualifications and educator certificates in 2021, there are 12 study programs in engineering and science. The author focuses on three engineering study programs qualified to become teacher candidates for the vocational high school renewable energy engineering expertise programs. 135 students participated in this study, consisting of 46

students in the electrical engineering education study program, 50 mechanical engineering education students, and 39 electrical engineering study programs, which consist of 97 male students and 38 female students. Energy literacy measurement follows the framework of the energy literacy measurement instrument, which can be seen in Table 1.

Table 1. Energy Literacy Instrument Framework

Domain	Indicator
Knowledge	• Scientific facts and basic concepts of energy • Issues and problems related to energy sources • Energy consumption • Impact of the development and use of energy resources on people, society, and the environment • Impact of individual and societal decisions related to the development of energy resources
Attitude	• Sensitivity to/awareness of the complexity and urgency of the global energy situation • Positive attitudes and values about energy and its policies • A strong sense of responsibility and conviction has to do with energy
Behavior	• Making energy savings • Making energy-related decisions that are effective and wise • Showing change-supporting behavior

Source: (DeWaters et al., 2007; DeWaters & Powers, 2011; DeWaters & Powers, 2008; DeWaters & Powers, 2013).

The research instruments are compiled following the possessions (DeWaters et al., 2007; Dewaters and Powers, 2011; DeWaters and Powers, 2008, 2013), which consists of 4 parts: (1) an introduction consisting of guidelines for filling in and filling in respondents' data, (2) 28 objective questions for assessing the domain of knowledge, (3) 25 statements with 4 Likert scales to assess the attitude domain. (4) 25 statements with 4 Likert scales to assess behavioral domains. The research instrument has been validated by three expert judgments from the Indonesian University of Education and Sunan Gunung Djati State Islamic University, after which it was given to respondents online with a google form. The data obtained is filtered with the help of ms excel and then analyzed with the use of SPSS software. A descriptive statistical analysis was carried out to explain the conditions of respondents' energy literacy based on the domains of knowledge, attitudes, and behaviors. Then a comparative statistical analysis was carried out. In normal and homogeneous data, t-tests and ANOVA were used. In contrast, in abnormal and heterogeneous data, Mann Whitney and Kruskal Wallis tests were used to obtain differences in energy literacy based on gender and study program origin of respondents.

RESULTS AND DISCUSSION

a. Conditions of Energy Literacy.

The results of measuring three domains of energy literacy of engineering students as vocational high school teacher candidates for renewable energy engineering expertise programs are shown in Table 2.

Table 2. Descriptive statistical analysis results

Domain literasi energi	Percent correct	Mean	SD
Knowledge	42,89	12,01	3,641

Attitude	82,74	3,33	10,364
Behavior	65,66	2,63	11,583

Table 2. Engineering students' average

domain of knowledge is 12.01 out of 28 knowledge questions, with an answer achievement rate of 42.89%. Not much different from the research of Lee et al. (2019) on nursing students who could only answer 42.7% of the total knowledge questions correctly. But those results were lower than other similar research studies. For example, the research results by Lee et al. (2016) acquisition of 59.8% of several agricultural and engineering students. Research results by DeWaters and Powers (2013) in high school students with a knowledge domain result of 44%. Research by S. J. Chen et al. (2015) in high school students with a knowledge gain of 63.10%. Research by Lee et al. (2015) with the results of knowledge domain achievement of 61.4% for junior high school and 63.83% for senior high school, and research by Derasid et al. (2021) with an acquisition of 81% for the knowledge of polytechnic teachers and lecturers. In the research, Dewaters and Powers (2011) define a person as being energy literate or having good energy literacy in the domain of knowledge if he can answer at least 75% of the total knowledge questions. In this study, there were 28 questions in the domain of knowledge. To achieve the criteria, respondents must answer at least 21 questions correctly. None of the respondents in this study were able to answer correctly 75% of the total knowledge questions. 56.3% of respondents correctly answer 50% of the total knowledge questions. 30.4% of them answered <50% but >75%. 13.3% of them answered >50% of the total knowledge questions. So it is concluded that the energy literacy of vocational teacher candidates is still low.

Most respondents understand the definition of energy in general but do not understand the difference between new and renewable energy sources. Respondents knew the types of conventional energy sources but did not understand the utilization of each of these energy sources. As for new and renewable energy sources, many still do not know the origin and utilization of each new and renewable energy source, especially bioenergy. Respondents need to update their knowledge about the most potent types of energy in conventional, new, and renewable energy as well as Indonesia's latest energy availability conditions. Knowledge of the pros and cons of developing renewable energy sources is still sorely lacking.

In table 2, it is also known that the average attitude of engineering students is 3.33 out of 4 Likert scales with an answer achievement rate of 82.74%. Slightly higher when compared to the results of the domain of energy literacy attitudes of agricultural students and several engineering majors in Taiwan. The average scale is 4.1 out of 5, with an achievement rate of 82% (Lee et al., 2016). The average attitude of nursing students is 3.76 out of 5 scales with an achievement rate of 75.2% (Lee et al., 2019). The average attitude of first and upper-secondary school students is 4.04 out of 5, with an answer achievement rate of 80%. However, it is still lower than the attitude of high school students in the study by (S. J. Chen et al., 2015), with an average attitude gain of 4.16 and an answer achievement rate of 83.42%. In the research of DeWaters and Powers

(2013), the minimum criterion for a person to be energy literate or have good energy literacy in attitudes and behaviors is the minimum average scale>2.5. So based on table 1, it can be said that engineering students as vocational high school teacher candidates have good energy literacy in the domain of attitudes. The results of energy literacy in the behavioral domain based on table 1 were 2.63 out of 4 scales with an answer achievement rate of 65.66%. It is not much different from the research of Dewaters and Powers (2011), with a behavioral domain answer achievement rate of 65.57%. However, it was lower than the findings of Lee et al. (2016) and S. J. Chen et al. (2015), with the achievement rates of behavioral domain answers being 72% and 68.6%, respectively. As mentioned earlier, the minimum criteria for attitudes and behaviors are>2.6, whereas the behavioral values in table 2 are slightly above the minimum limit. In table 2, there is also a considerable difference between attitude and behavior. These results prove that although engineering students as vocational high school teacher candidates show a positive attitude and support the issues of energy saving, accelerating energy transition, and energy education, it has not been fully implemented in daily energy behavior. Reinforced by DeWaters and Powers (2013), who argue that social situations strongly influence energy-related behaviors. This statement is supported and clarified by (Fang et al., 2021), that energy behavior is influenced by various socioeconomic factors (education, income), socio-demographic (age, gender), and subjective factors (knowledge and care).

b. Energy Literacy Based on Gender and The Study Program

The results of measuring three domains of energy literacy of engineering students as vocational high school teacher candidates for renewable energy engineering expertise programs based on gender and study program origin are shown in Table 3.

Table 3**.** The results of comparative statistical analysis

Variasi	Knowledge	Attitude	Behavior
Gender	0,404	0,12	0,099
Man	11,97	3,28	2,658
Woman	12,13	3,38	2,544
study program	0,028	0,028	0,716
EED	12,22	3,396	2,628
MED	11,08	3,067	2,660
EE	12,97	3,309	2,579

The testing of differences in knowledge domains by gender was carried out with the Mann-Whitney test due to abnormal and heterogeneous data. In table 2, it can be seen that the group of women has better average knowledge than men. However, the test results of Mann-Whitney obtained a significance value of 0.404, which was more significant than 0.05. This means that although the average group of women is better than the male group, the difference is not significant according to statistics. Furthermore, the difference in the average knowledge based on the study program uses the Kruskal Wallis test. This test was chosen instead of the ANOVA test due to abnormal and heterogeneous data. In table 2, the electrical engineering (EE) study program is in the first rank, electrical engineering education (EED) is in second place, and mechanical engineering education (MED) is in the last rank. The significance value of the Kruskal Wallis test

is 0.028 where the value is greater than 0.05. This means significant statistically significant differences between one study program and another. In the attitude domain, differences based on gender and study origin use t-tests and ANOVA because the data are normally distributed and homogeneous. In table 2, the average attitude of the women group is slightly better than the men's, although the differences are not significant. This is evidenced by the results of the t-test with a significance value of 0.12, where this value is greater than 0.05, which means that there is no significant difference between the attitudes of engineering students as vocational high school teacher candidates in the women's group and the men's group.

Based on the field of the engineering student study program as vocational high school teacher candidates, it was found that there was a significant average difference with a significance value of 0.028, with the electrical engineering education study program being in the first place and mechanical engineering education in the last order. Similar to the attitude domain, the behavioral domain also conducted t-tests and ANOVA to reveal behavioral differences based on gender and the study program. Previously, the Women group was better in knowledge and attitudes, but based on table 2, it was known that the male group showed better behavior than women. Although based on the results of the t-test, the difference is not significant, according to statistics. Previously in the domain of knowledge and attitudes, the mechanical engineering education study program was always in the last order, but in the behavioral domain, the mechanical engineering education study program was at the top of the list compared to other study programs. Although the significant results in table 2 0.716 showed that the difference in behavioral domains based on study program origin was not significant according to statistics.

DeWaters and Powers (2011) also explore gender among high school students in cognitive, affective, and behavioral aspects. The results showed that gender was only seen in parts of attitudes, with women showing better attitudes towards energy issues than men. The same research was also conducted in the Portuguese university community. It was found that women had a more positive attitude regarding energy use and saving than men. However, different results were shown when testing the relationship between knowledge and gender was carried out. It was found that there was no significant positive relationship between the two (Martins et al., 2020). Research on the influence of gender was also carried out on nursing students. The results showed that female college students have a much more positive energy attitude than male college students. However, their energy behavior is no better than that of male students (Lee et al., 2019).

In this study, all respondents received energy content but with different courses in each study program. Electrical Engineering Study Program and Electrical Engineering Education are each in the top order of average gain in knowledge and energy literacy attitudes. Based on the curriculum and syllabus of the two study programs, several courses are directly related and discuss in depth the energy content. Among them are courses in energy conversion, energy

economics, and new and renewable energy. There are also basic physics courses that insert a little basic energy content.

When compared to the mechanical engineering education study program, there is only one course that is directly related and discusses energy content in depth, namely energy conversion. In other courses, the energy content is slightly discussed but not in depth. Like the Heat Transfer course, which discusses a little about energy at the first meeting, and the Basic Physics course, which discusses a little bit about effort and energy. So it is assumed to be the factor causing the Mechanical Engineering Education Study Program to be the lowest on average in knowledge and energy literacy attitudes. Although in the domain of behavior is better than other study programs. As explained by Lee et al. (2016), students who do not major in environment and energy can still achieve energy literacy.

CONCLUSIONS AND SUGGESTIONS

Conclusions

The energy literacy knowledge of engineering students who qualified as vocational high school teacher candidates for renewable energy engineering expertise programs is low, with an achievement of 44.5%. The energy literacy attitude showed quite good results, with an achievement of 82.7%. As for the behavior of moderate energy literacy with an achievement of 65.6%. Based on gender, the knowledge and attitudes of female students are better than men, although these differences are not statistically significant. Male students are slightly better in the behavioral domain, although the differences are not statistically significant. Each study program gets energy content/material from different courses. Different content and energy content affect the results of energy literacy.

Suggestions

Implications of the results of this study can be the basis and reference material for developing models of energy literacy education and learning in universities. Universities need to pay attention to the content of energy materials equally in the curriculum of each study program, especially study programs that are qualified as vocational high school teacher candidates for renewable energy engineering expertise programs. Universities that act as Educational Personnel Education Institutions that are in charge of producing graduates of vocational teacher candidates should be given directions to open departments and study programs to the needs of vocational high schools. So that their educational qualifications are qualified and in line with the majors in vocational high school. The Indonesian University of Education has no special department or study program for energy, even though vocational high school renewable energy engineering expertise programs require educators who have appropriate educational qualifications.

The limitations of this research are carried out only in several study programs at one of the state universities. So it is hoped that researchers can then expand the scope of research with more variations or groups of study programs and be carried out in several universities to get a comparison of results. This study examines the level of energy literacy of vocational teacher candidates based on gender and study program.

However, age groups, differences in semester levels, and places of residence have not been studied so this topic could be a new finding in future studies.

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