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The Use of Solar Power Plant Media to Increase Literacy Ability Solar Energy of Students

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ABSTRAK

Tingkat literasi sains di kalangan pelajar Indonesia, khususnya dalam memahami energi surya sebagai sumber daya terbarukan, masih relatif rendah. Kekurangan ini dapat disebabkan oleh berbagai faktor, antara lain kurangnya pemanfaatan materi pendidikan yang bertujuan untuk meningkatkan literasi sains siswa. Tujuan utama penelitian ini adalah untuk meningkatkan kemampuan siswa dalam literasi energi surya dengan menerapkan materi pembelajaran pembangkit listrik tenaga surya. Purposive sampling digunakan untuk memilih peserta dari dua kelompok mahasiswa: Fakultas Keguruan dan Ilmu Pendidikan (FKIP) dan Fakultas Teknik (FT) yang telah menyelesaikan mata kuliah fisika gerak atau fisika dasar. Responden FKIP berjumlah 33 orang, terdiri dari 13 orang dari Program Studi Pendidikan Fisika, 6 orang dari Program Studi Pendidikan Kimia, dan 14 orang dari Program Studi Pendidikan Biologi. Sedangkan responden FT berjumlah 23 mahasiswa yang terdiri dari 9 orang dari Program Studi Teknik Elektro dan 14 orang dari Program Studi Teknik Mesin. Jadi, jumlah responden yang memenuhi kriteria penelitian ini berjumlah 56 siswa. Penilaian terhadap literasi energi surya meliputi tes pilihan ganda untuk aspek kognitif dan kuesioner untuk aspek afektif dan perilaku, yang dikelola melalui Google Formulir. Pemberian modul pembelajaran pembangkit listrik tenaga surya memberikan peningkatan pengetahuan dengan persentase jawaban benar meningkat pada mahasiswa FKIP dan mahasiswa FT dari pre-test hingga post-test. Kesimpulannya, kemampuan siswa dalam literasi energi surya dapat meningkat dengan menerapkan materi pembelajaran pembangkit listrik tenaga surya.

ABSTRACT

Indonesian students' science literacy level, especially in understanding solar energy as a renewable resource, still needs to be higher. This deficiency can be caused by various factors, including the need for more utilization of educational materials that aim to improve students' science literacy. The main objective of this study was to enhance students' solar energy literacy skills by applying solar power plant learning materials. Purposive sampling was used to select participants from two groups of students: Faculty of Teacher Training and Education (FKIP) and Faculty of Engineering (FT) who have completed physics of motion or introductory physics courses. FETT respondents numbered 33 people, consisting of 13 people from the Physics Education Study Program, 6 from the Chemistry Education Study Program, and 14 from the Biology Education Study Program. At the same time, The FT respondents were 23 students, consisting of 9 people from the Electrical Engineering Study Program and 14 from the Mechanical Engineering Study Program. Thus, the total number of respondents who met the criteria of this study amounted to 56 students. The assessment of solar energy literacy includes multiple-choice tests for cognitive aspects and questionnaires for affective and behavioral factors, which are managed through Google Forms. The provision of solar power plant learning modules increases knowledge, with the percentage of correct answers increasing in FKIP and FT students from pre-test to post-test. In conclusion, applying solar power plant learning materials can improve students' solar energy literacy skills.

1. INTRODUCTION

The main topic of discussion on energy literacy in Indonesia is one of the grand designs of the energy protection policy program in the context of every stakeholder's efforts to shape the character of society in consuming energy economically (Owners, 2022; Zulkarnaen et al., 2023). Energy literacy is a concrete action in education to build an understanding of attitudes and behavior and instill character to use energy efficiently and responsibly (Betaubun & Nasrawati, 2020; Rohmatulloh et al., 2021; Setiawati et al., 2020). It is hoped that energy literacy can direct each individual to play an active role in building public awareness of using energy wisely in everyday life. Every individual in society needs to develop an understanding and awareness that the continuous burning of fossil fuels can increase levels of greenhouse gases in the atmosphere as a result of carbon dioxide gas emissions (Navas Iannini & Pedretti, 2022;

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Rohmatulloh et al., 2022). This can also increase the intensity of the greenhouse effect which causes global warming, so efforts are needed to find a solution to this problem, one of which is by looking for environmentally friendly renewable energy sources. A good level of understanding of energy literacy can increase people's knowledge, attitudes, and behavior in utilizing energy wisely. Three aspects of energy literacy education, namely knowledge, attitudes, and behavior, are the main educational concepts towards the goal of energy literacy. Education for Sustainable Development Goals (SDGs) participates in developing students' energy literacy skills to support the learning goals of affordable and clean energy, which involves aspects of knowledge, attitudes, and behavior in social life (Nusrat & Ilham, 2020; Tibola da Rocha et al., 2020).

Because the literacy abilities of students in a country are so important, it is necessary to carry out an Because the literacy abilities of students in a country are so important, it is necessary to carry out an assessment of students' literacy abilities (Prasetia et al., 2022; Sukmawati & Zulherman, 2023). One program to assess a country's scientific literacy capabilities is through the Program for International Student Assessment (PISA). Indonesia's participation in PISA activities aims to determine the ranking position of Indonesian students' scientific literacy among students throughout the world who take part in the PISA assessment activities (Hartono et al., 2022; Rastuti & Prahmana, 2021; Sholikah & Pertiwi, 2021). The scores obtained by Indonesian students in the program were 383, 382, 403, and 396 out of a maximum score of 625 for 2009, 2012, 2015, and 2018 respectively. Based on the results obtained by Indonesian students in PISA activities, it show that their science literacy abilities are in the low category compared to students from other countries (Ramli et al., 2022; Sholikah & Pertiwi, 2021; Soniyah, 2021). The results of measurements carried out by the Trend in International Mathematics and Science Study (TIMSS) on Indonesian students in 2011 and 2015 ranked Indonesia in 38th position out of 46 countries and 64th out of 65 countries with a score of 382. These results show that Indonesian students' science literacy ability and mathematics is relatively low (Name et al., 2022; Sunandar et al., 2022; Suparya et al., 2022). The results of assessing the science abilities of Indonesian students through both PISA and TIMSS activities, the results of which are still relatively low, indicate that various efforts need to be made to improve the science literacy abilities of Indonesian students (Adnan et al., 2021; Sunandar et al., 2022).

The insufficient science literacy skills among Indonesian students stem from several factors, including the curriculum, learning materials, and students' learning preferences. Numerous endeavors have been undertaken to enhance students' science literacy by tailoring learning approaches to their needs and capacities, providing hands-on experiences and offering instructional aids (Juniartina, 2022; Labrie & Tang, 2022; Sunandar et al., 2022). Apart from that, other researchers stated that without providing real teaching resources such as teaching aids learning, students and teachers will not be able to learn effectively (Sidiq & Rif, 2022; Tzenios, 2020). An investigation conducted at a State Junior High School in Bandung implemented integrated science learning using a collaborative approach, resulting in an average N-gain value of 34% in the content section, indicating an improvement in student literacy abilities. Another study across six high schools in East Java involving 430 students revealed that science literacy levels in the content aspect were relatively low, with an average score of 58.80%. Furthermore, research on the energy literacy of high school students in Bandung indicated a significant deficiency, with teachers not fully addressing students' energy literacy needs during the learning process (Amzil et al., 2023; Sunarto, 2023; Suroso et al., 2021). Other researchers also investigated the energy literacy of high school students in Bandung, revealing that it remained notably deficient. Furthermore, teachers had not effectively integrated energy literacy into the learning curriculum (Adriyawati et al., 2020; Amzil et al., 2023; Suryana et al., 2020). The results of research conducted in the state of New York, United States of America on 2038 middle school students and 1216 high school students showed that their energy literacy ability in the cognitive were low category with their average scores achieving 40.17 and 44.36% for students's middle and high school respectively. In addition, energy literacy research was conducted on 1136 students at the University of Plymouth in England, showing that the majority of students surveyed, namely 81.2% of those surveyed, stated that they knew quite a bit to moderately about energy literacy. One tool used to see an increase in solar energy literacy is a solar power plant. Apart from the tools, modules about solar power plant knowledge start from the source of the formation of solar cells, how solar cells and solar panels and their components work (Bdour et al., 2020; Bosio et al., 2020). Through the presence of this media, it is hoped that new students can learn directly from these teaching aids (Rapanta et al., 2020; Zhang et al., 2020). Students have experience seeing directly how solar power plant works, starting from the tools and materials used, the process of installing photovoltaic panels, and how much output power is produced every day, as a source of electrical energy (Seme et al., 2020; Zhang et al., 2020).

Several attempts have been undertaken to enhance students' proficiency in science literacy, such as the creation of e-learning resources aimed at boosting their science literacy skills. These efforts resulted in an N-Gain test score of 0.57, indicating a moderate level of improvement (Putri et al., 2020; Risniawati et al., 2020; Tomczyk et al., 2020). Additionally, employing interactive multimedia during lessons was found to elevate students' science literacy, as evidenced by an N-Gain test score of 0.69, which falls within the moderate category. Furthermore, the implementation of student worksheets serves as another method to enhance students' science literacy skills (Hidayati et al., 2023; Popova & Jones, 2021; Sianturi et al., 2022). Because energy use is growing faster than available energy sources, good knowledge, attitudes, and behavior are needed towards more responsible energy use that can sustainably support human survival. Limited reserves of fossil energy sources encourage humans to use environmentally friendly renewable energy sources. Solar power technology is currently developing very rapidly and becoming increasingly advanced, which can have a big impact on human life, especially for progress in the field of education, one of which is the use of solar power technology in learning media. The technology used in learning media has been carried out to support students' understanding of the subject of renewable energy by utilizing solar power plants as a learning media (Hoque et al., 2022; Saputra et al., 2020; Wang & Guo, 2021). The use of learning media in the field of education provides a breakthrough in increasing efficiency and effectiveness in the learning process. However, until now there has been no research using solar power technology as a learning media that can improve students' energy literacy ability in general and new energy specifically. Therefore, this research aims to determine the effect of solar power plant learning media on increasing literacy of solar energy as a renewable energy source among new UKI students for the 2022/2023 academic year.

2. METHODS

This study utilizes a descriptive quantitative approach, employing purposive sampling as the sampling technique, where samples are selected based on specific criteria. The criteria outlined in this research involve respondents who must fulfill certain requirements, namely having taken or currently taking courses in either motion physics or basic physics at the Faculty of Teacher Training and Education, Fakultas Keguruan dan Ilmu Pendidikan (FKIP) or the Faculty of Engineering, Fakultas Teknik (FT) at the Indonesian Christian University, Universitas Kristen Indonesia (UKI). Among FKIP respondents, there were 33 students, comprising 13 from the Physics Education Study Program, 6 from the Chemistry Education Study Program, and 14 from the Biology Education Study Program. On the other hand, FT respondents totaled 23 students, with 9 from the Electrical Engineering Study Program and 14 from the Mechanical Engineering Study Program. Consequently, the total number of respondents meeting the criteria for this study amounted to 56 students.

The tool employed for assessing solar energy literacy is a written questionnaire crafted to gauge the adapted Energy Solar Literacy Questionnaire (ESLQ) created by DeWaters and Powers. This modified ESLQ comprises three key components: cognitive aspects (20 items), affective aspects about to solar energy (18 items), and energy-saving behavior (10 items). Both the affective and behavioral sections in both survey versions are uniform and employ a Likert-type response scale comprising five parts with one neutral option. Meanwhile, the cognitive aspect involves multiple-choice questions with five choices. The cognitive aspect covers six main topic areas, which include the basic concepts of renewable energy, the ability of solar cells to convert sunlight into a source of electrical energy, the importance of using electrical energy for daily living needs, the effect of light intensity on solar cells on current output, the differences between panels polycrystalline and monocrystalline solar, and circuits of off-grid and on-grid solar power plants and the impact of the development/use of energy resources on the environment. The affective aspect includes concern for global energy problems, positive attitudes and values, and personal responsibility in contributing to the development and use of sustainable renewable energy resources. Behavioral aspects include an attitude of willingness to work towards energy savings, thoughtful and effective thinking, and change advocacy. Overall, the distribution of solar energy literacy questionnaire questions for the three aspects is summarized in Table 1.

Table 1. Indicators of Solar Energy Literacy Instruments

Aspects	Indicator	Items
Cognitive	Knowing the basic concepts of renewable energy	C1, C10, C11, C12, C13 dan C18
	Knowing that solar cells can convert sunlight into a source of electrical energy	C2, C4, C15, and C19
	Being aware of importance of using electrical energy for daily living needs	C5, C6, C7, and C8
	Knowing effect of light intensity on solar cells on current output	C14 and C17

Aspects	Indicator	Items
Affective	Knowing of difference between polycrystalline and mono crystalline solar panels and off grid and on grid circuits of solar power plants	C16 and C20
	Comprehension regarding the environmental repercussions of energy resource development and utilization	C3 and C9
	Having concern for global energy problems	A2, A3, A4, A7, A8, A14 dan A17
	Have a positive attitude and values of renewable energy	A1, A5, A6, A9, A10, A16, and A18
	Taking individual accountability for contributing to the advancement of sustainable renewable energy resources, particularly solar energy.	A11, A12, A13, and A15
Behavior	Predispositions to behave :	
	Willing to work towards energy savings	P1, P2, P3, P4, P5, and P8
	Have wise and effective thinking	P6 and P7,
	Changing advocacy	P9 and P10

(This framework is adopted from Jan DeWaters, Susan Powers)

Respondents submitted their survey responses via Google Forms, which were electronically scanned into a Microsoft Excel spreadsheet form for analysis. Each item response was transformed into numerical scores based on specific criteria: cognitive items received five points for correct answers and zero points for incorrect ones, while Likert-type positive responses in affective and behavioral aspects were converted into numerical values ranging from one to five, reflecting the pre-defined choice responses. This process facilitated the calculation of total summed ratings for each aspect. Likert item responses ranged from one (strongly disagree) to five (strongly agree), with blank responses eliminated to ensure full participation. Scores for each aspect were analyzed separately, with a maximum score of 100 for the cognitive aspect, 90 for the affective aspect, and 50 for the behavioral aspect. Additionally, average item responses (ranging from 1 to 5) were computed for Likert-type affective and behavioral aspects, and the percentage of positive responses (score of 4 or 5) was calculated for each affective and behavioral item. Total scores for each aspect were converted into percentages of the maximum value to facilitate comparison across the three aspects

The survey results were analyzed according to the score achieved based on the criteria obtained for each aspect. Overall performance in each aspect was calculated for each group of FKIP and FT respondents. Respondents' responses to certain questions or topics in the three aspects surveyed. Especially for the cognitive aspect, a pre-test and post-test were carried out to determine the increase in their literacy skills by calculating the N-gain score based on each group of FKIP respondents, FT, and gender. The post-test was given to every group of students after being explained the solar power plant learning media. The media used in this research was validated by a mechanical engineering lecturer with expertise in energy conversion and then applied to respondents.

Non-parametric statistical analysis was employed to investigate potential disparities in students' solar energy literacy across different student groups and genders. The Mann-Whitney U test was utilized to compare mean scores (expressed as a percentage of the maximum achievable score) and students' responses to Likert-type affective and behavioral questions. The z-test of two population proportions was applied to compare respondents' performance on individual cognitive items. Furthermore, potential relationships among student performance in key questionnaire areas were assessed. The non-parametric Spearman's rank correlation (rho) was used to calculate the intercorrelation between students' average scores on cognitive, affective, and behavioral items for each Likert-type self-assessment question. Statistical analyses were conducted using Microsoft Excel and Statistical Package for Social Sciences (SPSS) Statistics Version 2.5.

3. RESULT AND DISCUSSION

Results

A summary of the survey results on solar power literacy skills from student groups for cognitive, affective, and behavioral aspects is presented in Table 2. The number of respondents (N) for student groups varied, namely 33 and 23 for FKIP and FT students. In the cognitive aspect, the survey was conducted twice, namely during the pre-test and post-test. Post-tests were given to students after a brief explanation about the learning media content of solar power plants as renewable energy sources by the researcher. The three aspects assessed consist of the median, mean, Standard Deviation (SD), minimum, maximum, average discrimination index, reliability, Standard Error of Measurement (SEM), and average item difficulty level which is calculated only on the cognitive aspects.

Table 2. Overall Solar Power Literacy Survey Results

	Cognitive (Pre-test)		Cognitive (Post-test)		Affective		Behavior	
	FKIP	**FT**	**FKIP**	**FT**	**FKIP**	**FT**	**FKIP**	**FT**
N	33	23	33	23	33	23	33	23
Median (%)	35.63	38.26	64.69	64.13	86.13	85.83	91.50	85.57
Mean (%)	30.00	40.00	65.00	65.00	83.00	87.00	95.50	88.00
SD (%)	14.07	13.53	22.25	20.49	7.79	13.62	8.99	16.23
Minimum	10	15	15	20	77	38	76	20
Maximum	65	70	95	95	100	100	100	100
Average item difficulty	0.36	0.38	0.65	0.46	-	-	-	-
Average discrimination index	0.99	0.11	0.48	0.44	0.45	0.87	0.85	0,76
Reliability	0.94	0.36	0.87	0.85	0.79	0.98	0.97	0.94
SEM (%)	3.50	4.90	16.04	7.80	7.80	13.60	8.90	16.20

Student results in sampling individual cognitive questions on both the pre-test and post-test are shown in Table 3, which consists of six indicators. The indicators asked about in this cognitive aspect are the basic concept of renewable energy, solar cells that can convert sunlight into a source of electrical energy, the importance of using electrical energy for daily living needs, the influence of light intensity on solar cells on current output, the differences between solar panels polycrystalline and monocrystalline as well as an off-grid and on-grid solar power plants circuits, and the impact the development/use of energy resources can have on the environment.

Table 3. Evaluation of Student Responses to a Subset of Cognitive Items, FKIP Versus FT Students

Indicator	% Correct (Pre-test)		% Correct (Post-test)		Probability	
	FKIP	**FT**	**FKIP**	**FT**	**Pre-test**	**Post-test**
Knowing the basic concepts of renewable energy	53	62	68	70	**<0,26**	**<0,26**
Knowing that solar cells can convert sunlight into a source of electrical energy	59	51	63	78	<0,53	**<0,53**
Being aware of importance of using electrical energy for daily living needs	20	30	56	50	<0,53	**<0,53**
Knowing effect of light intensity on solar cells on current output	48	43	72	61	**<0,201**	**<0,201**
Knowing of difference between polycrystalline and mono crystalline solar panels and off grid and on grid circuits of solar power plants	43	22	20	57	**<0,201**	**<0,201**
Comprehension regarding the environmental repercussions of energy resource development and utilization	33	30	45	52	**<0,201**	**<0,201**

A comparison of the results of positive responses and student probabilities for each indicator in the attitude and behavior aspect of each FKIP student towards FT is shown in Table 4. The indicators asked for the affective aspect are how concerned they are about global energy problems their positive attitudes and values towards energy use, and their responsibilities in contributing to the development and use of sustainable energy resources. Indicators that ask about behavioral aspects are how their habits work towards energy savings, wise and effective thinking about the use of renewable energy, and changing their advocacy to support the use of solar energy as a renewable energy source.

Table 4. Evaluation of Student Responses to Designated Affective and Behavioral Items, FKIP Versus FT Students

Indicator	% Positive Response		Probability
	FKIP	FT	
Affective items			
Having concern for global energy problems	78	81	0.123
Have a positive attitude and values	84	80	0.611
Taking individual accountability for contributing to the advancement of sustainable renewable energy resources, particularly solar energy	83	81	0.965
Behavioral items			
Willing to work towards energy savings	92	85	**<0.000**
Have wise and effective thinking)	91	80	0.138
Changing advocacy	88	83	0.365

In this study, differences in literacy solar power ability based on sex or gender were studied. The survey results for each cognitive, affective, and behavioral aspect are presented based on gender which is a union of both the FKIP and FT student groups presented in Table 5. There are differences in the average scores of men and women for all aspects surveyed, where women show average scores higher than men for cognitive and behavioral, but in the affective aspect, the average score for men is higher than women.

Table 5. Gender Contrasts in Cognitive, Affective, and Behavioral Aspects

	N	Mean (%)	Standard Deviation	Mean Rank	Probability
Cognitive					
Male	38	53.82	25.61	26.91	0.45
Female	17	57.94	23.12	30.44	
Affective					
Male	38	78.97	16.12	29.82	0.21
Female	17	65.29	10.79	23.94	
Behavior					
Male	38	78.12	17.23	25.87	0.13
Female	17	92.59	7.96	32.76	

This study further examined the interrelationships between student scores in affective and behavioral, cognitive and affective, and cognitive and behavioral aspects. Table 6 provides a summary of these intercorrelations among student scores in cognitive, affective, and behavioral aspects. The table includes the range, average, and standard deviation of individual correlation coefficients for two student groups: FKIP and FT students.

Tabel 6. Summary of Average Intercorrelation Coefficients Between Cognitive, Affective and Behavioral Aspects

	Correlation coefficients			Sig. (2-tailed)
	Range	Mean	SD	
Affective vs. behavioral aspect	0-20	0.10	6.86	0.160
Cognitive vs. affective aspect	0.41-0.60	0.50	6.67	0.553
Cognitive vs. behavioral aspect	0.81-1.00	0.91	6.67	0.833

The study of the increase in students' solar energy knowledge literacy was measured based on FKIP, FT, and gender student groups. This increase in cognitive literacy was obtained after all students were given treatment through a brief explanation of the solar power plants module as a media so that their post-test scores were obtained. The literacy improvement category for each group of students is determined based on the range of N-Gain scores obtained by each group of respondents as summarized in Table 7.

Tabel 7. The Increasing Student Solar Power Cognitive Literacy Based on N-Gain Score

Respondent group	N-Gain Score	N-Gain Score Range	Category
FKIP	44	0.30 ≤ N-Gain ≤ 0.70	Moderate
FT	42	0.30 ≤ N-Gain ≤ 0.70	Moderate
Female	42	0.30 ≤ N-Gain ≤ 0.70	Moderate
Male	44	0.30 ≤ N-Gain ≤ 0.70	Moderate

Discussion

Table 2 indicates a high internal consistency across all three aspects assessed, as evidenced by Cronbach's alpha values ranging from 0.79 to 0.98. However, there is less consistency in the cognitive pretest scores of FT students, with a Cronbach's alpha value of 0.36. Despite this, these aspects effectively distinguish between students achieving high and low scores (Chew & Cerbin, 2021; Stroebe, 2020). Additionally, the survey revealed that the cognitive literacy skills of solar power plant students were initially quite low, with average scores of 30 and 40 for FKIP and FT students, respectively. Following the intervention, which involved providing a learning module on solar power plants as a renewable energy source to both student groups, there was a notable increase in their cognitive literacy scores. The average scores rose from 30 and 40 during the cognitive pretest to an average of 65, with N-Gain test scores ranging from 0.30 to 0.70 in the moderate category for each FKIP and FT student, as presented in Table 7. These findings align with those of previous researchers. The question difficulty level is assessed by comparing the proportion of respondents who answered each question correctly to those showing score improvements from pre-test to post-test, ranging from 36-65% for FKIP students and 38-46% for FT students. On average, the difficulty level of the questions falls within the range of 0.36 to 0.65, indicating a good to very good level (Mahjabeen et al., 2017; Musa et al., 2021; Reinstein et al., 2021; Samsudin et al., 2021). The maximum score in the cognitive aspect experienced a very good increase, namely from 65-95 and 70-95 for the FKIP and FT student groups respectively.

The probability (p) of differences in student responses was determined using the z-test for the proportion of two populations, with significance values of 0.434 and 0.730. All p-values for both pre-test and post-test scores were found to be less than 0.434 and 0.730 respectively, indicating significant differences in results between FKIP and FT students, as highlighted in bold in Table 3. Analysis of student responses to cognitive indicators during the post-test, with probability values lower than 0.730, revealed significant disparities in knowledge or cognitive aspects between FKIP and FT students across all indicators in solar power cognitive literacy. Notably, FKIP students demonstrated a greater knowledge increase compared to FT students following exposure to solar power generation modules, as indicated in Table 7. The percentage of correct answers for the indicator assessing the effect of light intensity on solar cells' current output in the post-test was notably higher for both FKIP and FT student groups, reaching 72% and 61% respectively, surpassing previous findings reported by researchers(Fritz et al., 2020; Michaels et al., 2021) .

Table 3 summarizes the comparison of the percentage increase in correct answer sample items from pre-test to post-test on the six knowledge indicator items from the two groups of students surveyed. Based on the answers they gave, it shows that the student group experienced the highest increase in correct answers on the indicator of realizing the importance of using electrical energy for daily living needs by 36% of the FKIP student group and on the indicator of knowing the difference between polycrystalline and monocrystalline solar panels and the off-grid and on-grid solar power plants circuits amount to 35% of the FT student group (Maurer et al., 2020; Nur'aini et al., 2023). Overall, the indicators asked about the cognitive aspect of the FT student group experienced an increase in the average percentage of correct answers by 21.50%, while FKIP students only experienced an increase of 11.33%.

Table 4 illustrates students' responses concerning attitudes and behaviors toward solar power. It showcases students' overall positive attitudes and values toward energy, demonstrating concern for global energy issues and a sense of personal responsibility in promoting the development and sustainable utilization of renewable energy resources. A comparison of the average percentage of positive responses on affective and behavioral aspects between FKIP and FT students reveals ratios of 81.66:80.66 and 90.33:82.66 respectively. These results show that there is no difference in the attitudes of FKIP students and FT students. The responses of the two groups of students on behavioral aspects were generally the same, except for the indicator of their willingness to work towards saving energy which was found to be different between the two groups of students. The probability of differences in the responses of FKIP and FT students is calculated using the Mann-Whitney U test, namely in the results section in bold in Table 4 with a P score of less than 0.05 which indicates that there is a significant difference in behavior in the indicator of their willingness to work towards saving energy from the two groups. These results are different from those reported by other researchers where positive responses on affective and behavioral aspects were obtained in a lower percentage (Li et al., 2020; Marín-Morales et al., 2020).

Solar energy literacy ability of students based on the male/female ratio for cognitive, affective, and behavioral aspects have been calculated and then shown in Table 5. The average score for the cognitive and behavioral aspects of women is higher than for men, but for the affective aspect, the average score of men is higher than women (Bahrami & Mohammadi, 2021; El-Kanj et al., 2022). In the behavioral aspect, it was found that the average score for women reached 92.59% while for men it was only 78.12%, which means that in daily practice, women's behavior in working towards energy savings, wise and effective thinking and changing life advocacy is much higher compared to men. The probability of differences in female and male students' responses to the three aspects surveyed was calculated by using the Mann-Whitney U-test, the probability (P) scores for all aspects were less than 0.05, indicating that there were no significant differences in solar power plants literacy ability between the men and women groups of all students surveyed. These results are in accordance with those reported by previous researchers (Debowska et al., 2022; Peng et al., 2020).

The results of calculating the intercorrelation coefficient between the three aspects assessed, namely the correlation coefficient between affective and behavioral, cognitive and affective, and cognitive and behavioral are shown in Table 6. The correlation coefficient between the affective and behavioral aspects is in the range of 0-20, which means the correlation of both aspects is a weak correlation category, the correlation coefficient between the cognitive and affective aspects is in the range of 0.41-0.60, which means the correlation of both aspects is in the medium correlation category, and the correlation coefficient between the cognitive and behavioral aspects is in the range 0.81-1.00, which means the correlation of both aspects is very strong correlation category as previously reported. The results of these intercorrelation calculations illustrate that high literacy knowledge about solar power plants will be able to strongly influence their behavior in changing their advocacy, carrying out work towards energy savings, and having wise and effective thinking (Chicco et al., 2021; Chicco & Jurman, 2020). While not all aspect intercorrelations proved statistically significant across all student groups surveyed, there was a notably strong correlation coefficient of 0.91 between cognitive aspects and behavior. The disparity between the correlation coefficients of cognitive and affective (0.50) compared to cognitive and behavioral aspects underscores the significant role of student influence in shaping responsible energy-related behavior. It emphasizes the importance of maintaining this influence to ensure the sustainability of renewable energy sources, aligning with the objectives outlined in the sustainable development goals (Hoque et al., 2022; Queiruga-Dios et al., 2020). Solar energy literacy encompasses not just knowledge but also attitudes, values, decisions, and everyday behaviors. Therefore, a primary objective of renewable energy education is to foster and reinforce a favorable outlook toward environmental consciousness and promote technological innovation among students. This is achieved by imparting comprehension and the requisite skills for devising and executing sustainable solutions to tackle global energy issues.

The objective of knowledge literacy is to enhance students' critical thinking abilities and cultivate positive attitudes and behaviors toward decision-making (Mohseni et al., 2020; Sukri, A., Rizka, M. A., Purwanti, E., Ramdiah, S., & Lukitasari, 2022). The findings of this study indicate observable improvements in students' solar energy literacy following a brief introduction to solar power generation modules as an educational tool (Gerhátová et al., 2020; Mohseni et al., 2020). This medium is deemed effective in enhancing their solar energy literacy skills, as evidenced by their N-Gain scores falling within the moderate category, ranging from 0.3 to 0.7, as depicted in Table 7.

This research has the advantage of increasing students' understanding of solar energy and renewable technology. By utilizing solar power generation media, students can learn practically how this system works, its benefits, and the challenges faced. Using solar power plant media in learning offers a more practical and interactive approach than theory. Students can see first-hand how solar energy is converted into electricity and understand the basic principles of this technology. The implication is that this research can trigger the integration of renewable energy technologies, particularly solar power, into the school curriculum. Schools can provide more relevant and applicable materials by incorporating media-based learning on solar power generation. However, this research has limitations in that integrating solar energy technology into the existing curriculum may require significant adjustments. This may affect schedules and other subject matter requiring curriculum managers' time and effort.

4. CONCLUSION

The results of the solar energy literacy survey as a renewable energy source have been calculated and analyzed. The literacy aspects measured include cognitive, affective, and behavioral which consist of several indicators. Providing media in the form of solar power plant learning modules to FKIP and FT student groups can increase the average value of knowledge for FKIP and FT student groups. Based on the Mann-Whitney U test, the probability value found a difference in attitude/behavior on the indicator "willing to make efforts to save energy". Their solar energy knowledge literacy skills have increased with N-Gain scores in the medium category for all student groups surveyed.

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