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Digital Competence, Energy Literacy, and Attitude in Students' Transition Readiness

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Abstract−The transition toward sustainable energy requires not only technological and policy transformation but also student readiness as future professionals and decision makers. This study examines whether green digital competence and sustainable energy literacy predict energy transition readiness, and whether pro-environmental attitude mediates these relationships among STIM Sukma students. A quantitative explanatory survey was conducted using a structured Likert-scale questionnaire. After screening for active student status and voluntary consent, 71 valid responses were analyzed using SPSS-style procedures, including descriptive statistics, validity and reliability testing, correlation, multiple regression, and bootstrap-based mediation analysis. The results show that sustainable energy literacy is the most stable predictor of energy transition readiness. Pro-environmental attitude also significantly predicts readiness and partially mediates the relationship between sustainable energy literacy and readiness. Green digital competence significantly predicts pro-environmental attitude, but its direct and indirect effects on readiness are not statistically supported in the simultaneous model. These findings highlight the importance of integrating energy literacy, environmental attitude formation, and responsible digital competence in higher education sustainability programs.

Keywords: Green Digital Competence; Sustainable Energy Literacy; Pro-Environmental Attitude; Energy Transition Readiness; Higher Education

1. INTRODUCTION

The transition toward sustainable energy has become a strategic global agenda because energy systems determine the capacity of societies to reduce emissions, strengthen economic resilience, and create sustainable development pathways. At the global level, energy transition progress has improved in several dimensions, but transition readiness remains vulnerable to energy security, investment, and institutional capacity challenges (World Economic Forum, 2025). For Indonesia, the issue is particularly important because the country must maintain energy access and economic growth while accelerating renewable energy deployment and reducing dependence on fossil fuels. The International Energy Agency (Agency, 2022) explains that Indonesia's power sector must improve flexibility, efficiency, and renewable integration to meet its renewable energy targets, while the Institute for Essential Services Reform (Reform, 2024) describes the national energy transition as a critical turning point that requires policy consistency and broader public participation. These conditions show that energy transition is not merely a technical or governmental issue; it also requires human readiness, knowledge, values, and behavioral orientation.

Higher education institutions have a central role in preparing young people for sustainable transformation. UNESCO (UNESCO, 2026) emphasizes that education for sustainable development equips learners with the knowledge, skills, values, and agency required to address sustainability challenges. This educational mandate is particularly relevant to students in management and digital business fields because they will enter workplaces where energy efficiency, responsible technology use, green operations, and sustainability reporting are increasingly important. STIM Sukma students therefore represent a meaningful population for examining energy transition readiness. Their readiness is likely to be shaped by how they understand sustainable energy, how they use digital technologies, and how they evaluate environmental responsibility.

Green digital competence is one of the emerging competencies needed in this context. The concept integrates digital competence and sustainability competence. DigComp 2.2 defines digital competence as the confident, critical, safe, and responsible use of digital technologies, while GreenComp conceptualizes sustainability competence as the knowledge, skills, and attitudes required to act responsibly for the planet and public health (Bianchi et al., 2022; Vuorikari et al., 2022). In higher education, digital competence can promote sustainable and innovative learning when it is directed toward meaningful educational goals (Rahman, 2023). OECD similarly highlights the need for higher education to cultivate competencies for digital and green innovation. Thus, students' ability to search, evaluate, and use digital information responsibly may contribute to their environmental orientation and readiness for energy transition.

Sustainable energy literacy is another important factor. Energy transition depends on citizens' understanding of renewable energy, energy efficiency, environmental consequences of energy use, and the social urgency of moving toward cleaner energy systems. Recent research among Indonesian youth found that sustainability literacy contributes to sustainable energy consumption and that attitude-related mechanisms strengthen this relationship (Hakam et al., 2025). Energy literacy is also increasingly recognized as a foundation for preparing students to address climate change and the transition to renewable energy. In this study, sustainable energy literacy is treated as a domain-specific form of knowledge that may directly predict students' readiness to support the energy transition.

Pro-environmental attitude is theoretically central because knowledge and competence do not always translate into readiness. The Theory of Planned Behavior explains that attitude toward a behavior is one of the main

determinants of intention and behavioral orientation (Ajzen, 1991). Studies in higher education confirm that attitude and related psychological factors are important in explaining students' pro-environmental behavior and participation in sustainability initiatives (Correia et al., 2022; Huzer et al., 2025). Indonesian studies on environmental literacy and sustainability competence also show that education can strengthen ecological awareness and environmental. Accordingly, this study positions pro-environmental attitude as a mediating variable that may explain how competence and literacy are translated into readiness.

Previous studies have examined digital competence, sustainability competence, energy literacy, and pro-environmental behavior, yet several gaps remain. First, digital competence and sustainability competence are often studied separately, although students increasingly need to integrate digital capability with ecological responsibility. Second, sustainable energy literacy is frequently linked to consumption behavior, while less attention has been given to energy transition readiness as a broader outcome. Third, attitude is commonly treated as a direct predictor, but its mediating role between competence, literacy, and readiness remains underexplored. Fourth, empirical evidence from Indonesian private higher education contexts is still limited. This study addresses these gaps by testing an integrated explanatory model among STIM Sukma students.

The purpose of this study is to examine whether green digital competence and sustainable energy literacy predict energy transition readiness and whether pro-environmental attitude mediates these relationships. The study contributes theoretically by extending the Theory of Planned Behavior through a literacy-attitude-readiness pathway and by integrating GreenComp and DigComp perspectives into a student-level green digital competence model. Practically, the findings are expected to support STIM Sukma and similar institutions in designing sustainability-oriented learning, digital literacy programs, and campus initiatives that strengthen student readiness for sustainable energy transition.

2. RESEARCH METHODS

2.1 Basic Research Framework

This study used a quantitative explanatory survey design. The quantitative approach was selected because the research tested measurable relationships among variables and estimated direct and indirect effects. The explanatory design was appropriate because the study aimed not only to describe students' perceptions but also to explain how green digital competence and sustainable energy literacy predict energy transition readiness through pro-environmental attitude. The empirical data were collected from STIM Sukma students through a structured online questionnaire using a five-point Likert scale.

The population of the study consisted of active STIM Sukma students. The sample was selected through purposive sampling because respondents had to meet specific inclusion criteria: active student status, voluntary participation, and complete questionnaire responses. The initial dataset contained 74 responses, and 71 responses were retained after screening. Three responses were excluded because they did not meet the active-student and consent criteria. The final sample was therefore considered suitable for regression-based analysis.

The research model includes four variables. Green digital competence and sustainable energy literacy serve as independent variables, pro-environmental attitude serves as the mediating variable, and energy transition readiness serves as the dependent variable. The logic of the model is derived from the Theory of Planned Behavior, which positions attitude as a psychological factor that helps transform knowledge and competence into behavioral readiness (Ajzen, 1991). The model is also supported by DigComp 2.2 and GreenComp as frameworks for digital and sustainability competence (Bianchi et al., 2022).

The hypotheses tested in this study are as follows: H1 states that green digital competence has a positive effect on energy transition readiness; H2 states that sustainable energy literacy has a positive effect on energy transition readiness; H3 states that green digital competence has a positive effect on pro-environmental attitude; H4 states that sustainable energy literacy has a positive effect on pro-environmental attitude; H5 states that pro-environmental attitude has a positive effect on energy transition readiness; H6 states that pro-environmental attitude mediates the relationship between green digital competence and energy transition readiness; and H7 states that pro-environmental attitude mediates the relationship between sustainable energy literacy and energy transition readiness.
Green Digital Competence --> Pro-Environmental Attitude --> Energy Transition Readiness
Sustainable Energy Literacy --> Pro-Environmental Attitude --> Energy Transition Readiness
Green Digital Competence and Sustainable Energy Literacy also have direct paths to Energy Transition Readiness.

2.2 Instrument and Measurement

The research instrument consisted of 28 main items measuring four constructs. Each construct was measured using seven Likert-scale indicators ranging from 1 (strongly disagree) to 5 (strongly agree). Green digital competence measured students' ability to use digital technologies responsibly and sustainably. Sustainable energy literacy measured students' knowledge of renewable energy, energy efficiency, and energy transition issues. Pro-environmental attitude measured students' favorable evaluation of environmental protection and energy conservation. Energy transition readiness measured students' preparedness to support, accept, and participate in sustainable energy transition initiatives.

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Table 1. Research Variables and Measurement

Variable	Code	Role	Items	Scale
Green Digital Competence	GDC	Independent variable	7	Likert 1-5
Sustainable Energy Literacy	SEL	Independent variable	7	Likert 1-5
Pro-Environmental Attitude	PEA	Mediating variable	7	Likert 1-5
Energy Transition Readiness	ETR	Dependent variable	7	Likert 1-5

Data analysis was conducted using SPSS-style statistical procedures. The analysis included descriptive statistics, corrected item-total correlation for validity testing, Cronbach's alpha for reliability testing, Pearson correlation, classical assumption testing, multiple linear regression, and bootstrap-based mediation analysis. Likert-scale data were treated through composite mean scores because the study examined construct-level relationships rather than item-level differences (Sullivan & Artino, 2013). Mediation testing followed a regression-based approach consistent with PROCESS Model 4 logic (Hayes, 2022). Ethical screening was applied by retaining only respondents who confirmed active student status and voluntary consent.

3. RESULTS AND DISCUSSION

3.1 Respondent Profile and Descriptive Results

The final sample consisted of 71 valid STIM Sukma students. Female respondents dominated the sample, and most respondents were from the S1 Management program. Most respondents were from the 2025 cohort and were in the second semester. The majority reported using digital technology every day, and most had previously received information related to environmental, energy, sustainability, green business, or energy-saving issues. This profile supports the relevance of the sample for examining green digital competence, energy literacy, environmental attitude, and transition readiness.

Table 2. Respondent Profile

Characteristic	Dominant Category	Frequency	Percentage
Gender	Female	56	78.87%
Study Program	S1 Management	38	53.52%
Cohort	2025	66	92.96%
Semester	Semester 2	67	94.37%
Digital Technology Use	Every day	56	78.87%
Prior Environmental/Energy Information	Yes	54	76.06%

Table 2 shows that the respondents were highly exposed to digital technology and that most had encountered environmental or energy-related information. These characteristics are important because the study investigates the intersection of digital competence, energy literacy, environmental attitude, and readiness for energy transition.

Table 3. Descriptive Statistics and Reliability

Variable	N	Mean	SD	Cronbach's Alpha
Green Digital Competence	71	3.51	1.22	0.976
Sustainable Energy Literacy	71	3.42	1.17	0.977
Pro-Environmental Attitude	71	3.54	1.22	0.983
Energy Transition Readiness	71	3.49	1.21	0.985

Table 3 indicates that all variables were located in the moderate-to-high range on a five-point scale. Pro-environmental attitude had the highest mean, followed by green digital competence, energy transition readiness, and sustainable energy literacy. The Cronbach's alpha values were above 0.90 for all constructs, indicating very high internal consistency. This suggests that the items within each construct consistently measured the intended variables.

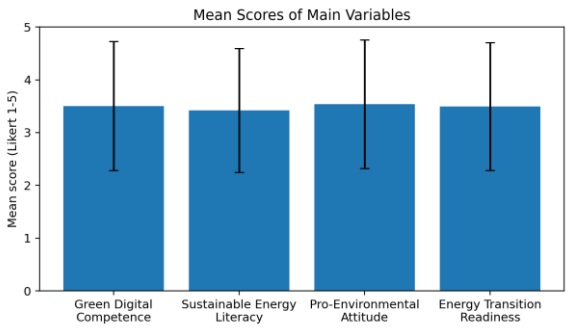

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Figure 2. Mean Scores of Main Research Variables

Figure 2 confirms that the four variables had relatively similar mean scores, with pro-environmental attitude slightly higher than the other constructs. The variation shown by the error bars indicates that students did not respond uniformly, which supports the relevance of further analysis to examine relationships among variables.

3.2 Validity, Correlation, and Assumption Testing

Corrected item-total correlation was used to examine item validity. All items exceeded the minimum acceptance criterion and were retained for analysis. The lowest item-total correlation was within the strong range, and the highest item-total correlation indicated very strong item consistency. The reliability results further confirmed that the constructs were internally consistent.

Table 4. Summary of Item Validity

Construct	Number of Items	Lowest Corrected Item-Total Correlation	Highest Corrected Item-Total Correlation	Decision
GDC	7	0.872	0.933	Valid
SEL	7	0.877	0.965	Valid
PEA	7	0.911	0.961	Valid
ETR	7	0.927	0.952	Valid

Table 4 shows that all items were statistically valid. The validity pattern also explains the high reliability values reported in Table 3. Because every construct had valid and reliable indicators, the composite scores were considered appropriate for correlation, regression, and mediation analysis.

Table 5. Correlation Matrix

Variable	GDC	SEL	PEA	ETR
GDC	1.000	0.931	0.885	0.856
SEL	0.931	1.000	0.912	0.925
PEA	0.885	0.912	1.000	0.891
ETR	0.856	0.925	0.891	1.000

Table 5 shows that all variables were strongly and positively correlated. The strongest relationship was between green digital competence and sustainable energy literacy, followed by the relationship between sustainable energy literacy and energy transition readiness. These correlations indicate that the constructs are empirically related. However, the very high correlations also signal possible multicollinearity when the variables are included simultaneously in regression models.

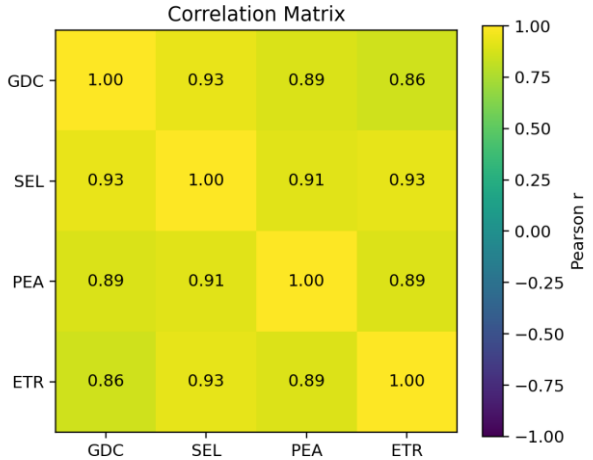

Figure 3. Correlation Matrix among Variables

Figure 3 visually confirms the strong positive correlations among the variables. The dense correlation pattern supports the conceptual relationship among competence, literacy, attitude, and readiness, but it also requires cautious interpretation of individual regression coefficients.

Classical assumption testing showed that heteroscedasticity was not detected, but residual normality was not fully satisfied. The most important diagnostic issue was multicollinearity. The variance inflation factors in the final model were high, particularly for sustainable energy literacy. This condition means that the unique effects of individual predictors may become unstable because the predictors share substantial explanatory variance.

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Table 6. Assumption Test Summary

Assumption	Result	Decision
Normality	Residual normality was not fully satisfied	Interpret cautiously
Heteroscedasticity	No heteroscedasticity detected	Met
Multicollinearity	VIF GDC = 7.95; SEL = 10.24; PEA = 6.33	Not fully met
Linearity	Positive linear pattern observed	Met

Table 6 indicates that the regression results should be interpreted with attention to multicollinearity. The mediation analysis therefore emphasizes bootstrap confidence intervals, and the discussion interprets the non-significant green digital competence path cautiously.

3.3 Regression and Mediation Results

Table 7. Regression Model Predicting Pro-Environmental Attitude

Predictor	B	SE	Beta	t	p
Constant	0.239	0.183	-	1.306	0.196
Green Digital Competence	0.271	0.132	0.272	2.062	0.043
Sustainable Energy Literacy	0.686	0.137	0.659	5.003	<.001
Model Fit	R2 = 0.842			F = 181.362	<.001

Table 7 shows that green digital competence and sustainable energy literacy jointly explained a large proportion of variance in pro-environmental attitude. Both predictors were significant, but sustainable energy literacy showed the stronger standardized coefficient. This means that students who understood sustainable energy issues more strongly tended to report more favorable environmental attitudes, while green digital competence also contributed positively to attitude formation.

Table 8. Regression Model Predicting Energy Transition Readiness

Predictor	B	SE	Beta	t	p
Constant	0.169	0.167	-	1.013	0.315
Green Digital Competence	-0.122	0.122	-0.124	-1.001	0.320
Sustainable Energy Literacy	0.784	0.144	0.761	5.430	<.001
Pro-Environmental Attitude	0.303	0.109	0.306	2.773	0.007
Model Fit	R2 = 0.871			F = 151.201	<.001

Table 8 indicates that the final model significantly explained energy transition readiness. Sustainable energy literacy and pro-environmental attitude were significant predictors, while green digital competence was not significant when the other variables were controlled. The model explained a large amount of readiness variance, but the non-significant green digital competence coefficient should be interpreted in light of the high correlation among predictors.

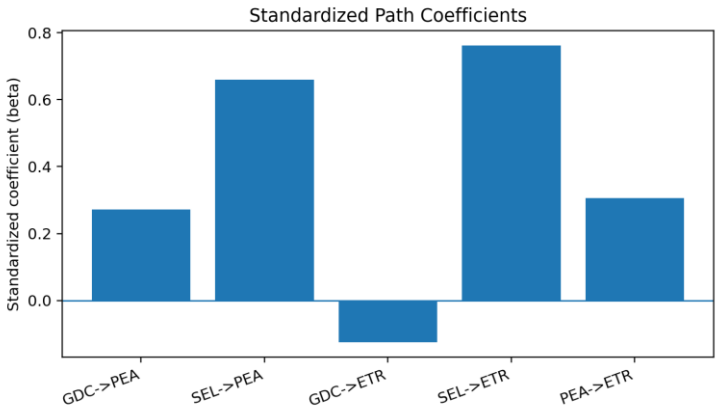

Figure 4. Standardized Path Coefficients

Figure 4 shows that sustainable energy literacy had the strongest positive path to energy transition readiness. Pro-environmental attitude also had a positive path, while green digital competence showed a negative but non-significant coefficient in the final simultaneous model. This pattern suggests that energy-specific literacy is more directly connected to readiness than general green digital capability.

Table 9. Mediation Analysis Summary

Indirect Path	Indirect Effect	95% Bootstrap CI	Decision

GDC -> PEA -> ETR	0.082	-0.022 to 0.216	Not supported
SEL -> PEA -> ETR	0.208	0.029 to 0.484	Supported

Table 9 shows that pro-environmental attitude did not significantly mediate the relationship between green digital competence and energy transition readiness because the confidence interval included zero. In contrast, pro-environmental attitude significantly mediated the relationship between sustainable energy literacy and energy transition readiness because the confidence interval did not include zero. Since the direct effect of sustainable energy literacy remained significant, the mediation pattern can be described as partial mediation.

3.4 Discussion

The findings demonstrate that sustainable energy literacy is the most consistent predictor of energy transition readiness among STIM Sukma students. This result is conceptually reasonable because energy transition is a domain-specific issue. Students need to understand renewable energy, energy efficiency, environmental consequences, and the social importance of shifting away from fossil-based systems before they can develop readiness to support transition initiatives. This finding is consistent with Hakam et al. (2025), who reported that sustainability literacy influenced sustainable energy consumption among Indonesian youth. The present study extends that evidence by showing that literacy also predicts readiness, not merely consumption behavior.

Pro-environmental attitude also significantly predicted energy transition readiness. This supports the Theory of Planned Behavior because students who evaluate environmental protection positively are more likely to show readiness to support sustainability-oriented transformation (Ajzen, 1991). (Correia et al., 2022) and Huzer et al. (Huzer et al., 2025) similarly found that attitude-related factors help explain students' pro-environmental behavior and sustainability participation in higher education contexts. In this study, students with stronger environmental attitudes were more willing to support energy-saving behavior, renewable energy orientation, and campus sustainability initiatives.

The mediation finding provides an important theoretical contribution. Pro-environmental attitude partially mediated the relationship between sustainable energy literacy and energy transition readiness. This means that literacy influences readiness directly and also indirectly by shaping favorable environmental attitudes. In educational terms, energy literacy is not only cognitive; it can also become affective and motivational when students connect energy issues with environmental responsibility. This supports the argument that education for sustainable development should integrate knowledge, values, and agency rather than treating sustainability learning as information transfer alone (UNESCO, 2026).

Green digital competence significantly predicted pro-environmental attitude, indicating that students who use digital technologies critically and responsibly tend to show stronger environmental orientation. This finding is compatible with DigComp 2.2 and GreenComp, which emphasize responsible digital engagement and sustainability competence (Bianchi et al., 2022; Vuorikari et al., 2022). It is also aligned with OECD (2024), which highlights the importance of competencies for digital and green innovation in higher education. However, green digital competence did not significantly predict energy transition readiness when sustainable energy literacy and pro-environmental attitude were included in the model.

The non-significant direct effect of green digital competence should not be interpreted as evidence that digital competence is unimportant. The bivariate correlation between green digital competence and readiness was strong, but its unique effect became non-significant in the simultaneous model. This pattern is most likely influenced by multicollinearity because green digital competence, sustainable energy literacy, and pro-environmental attitude were highly intercorrelated. Another explanation is that energy transition readiness requires energy-specific knowledge, while green digital competence may function as a supporting competence that helps students access information and develop environmental attitudes rather than directly determining readiness.

Practically, the results suggest that STIM Sukma should strengthen sustainable energy literacy across learning activities. Energy transition can be integrated into management, digital business, entrepreneurship, operations, and organizational behavior courses. Students can be assigned to analyze renewable energy business models, green supply chains, campus energy efficiency, and sustainable digital business practices. These activities would help students understand energy transition not only as an environmental issue but also as a managerial, technological, and economic challenge.

The significant role of pro-environmental attitude also implies that sustainability programs should cultivate values and concern, not only deliver information. Campus campaigns, energy-saving challenges, student projects, green community activities, and digital sustainability campaigns can help students internalize environmental responsibility. Since green digital competence predicts attitude, digital platforms can be used as tools for environmental engagement, such as online campaigns, sustainable energy learning modules, and student-created digital content about energy conservation.

The study has limitations. The sample was drawn from one institution and consisted of 71 valid respondents, so generalization should be made carefully. The cross-sectional design limits causal interpretation, and self-reported data may contain social desirability bias. The high multicollinearity among predictors also suggests the need for refined instruments and larger samples in future studies. Future research may use structural equation modeling, expand

the sample to multiple campuses, and include variables such as subjective norms, perceived behavioral control, institutional support, green campus culture, or digital sustainability engagement.

4. CONCLUSION

This study concludes that energy transition readiness among STIM Sukma students is primarily strengthened by sustainable energy literacy and pro-environmental attitude. Sustainable energy literacy significantly predicts readiness and also influences readiness indirectly through pro-environmental attitude, indicating that energy-related knowledge becomes more effective when it shapes favorable environmental evaluations. Pro-environmental attitude also directly contributes to readiness, confirming the relevance of the Theory of Planned Behavior in explaining students' preparedness for sustainability-oriented action. Green digital competence significantly contributes to pro-environmental attitude, but its direct and indirect effects on energy transition readiness are not statistically supported in the simultaneous model, most likely because of high overlap among the predictors and because energy-specific knowledge is more proximal to readiness than general digital-green capability. The study contributes to sustainability education by showing the importance of integrating literacy, attitude, and responsible digital competence in preparing students for energy transition. However, the findings are limited by the single-institution sample, cross-sectional design, self-reported data, and multicollinearity. Future studies should involve larger multi-campus samples, apply structural equation modeling, and include institutional and behavioral variables to provide a more comprehensive explanation of student readiness for sustainable energy transition.

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