

DOI: 10.2478/jtes-2026-0005

Journal of Teacher Education for Sustainability,
vol. 28, no. 1, pp. 73–95, 2026

Pre-Service Teachers' Readiness for Green Pedagogy: The Impact of Institutional Support, Environmental Awareness, and Sustainability Mindset

Tusyanah Tusyanah

<https://orcid.org/0000-0003-0748-0919>

Universitas Negeri Semarang, Semarang, Indonesia

Ismiyati Ismiyati

<https://orcid.org/0000-0003-4444-3180>

Univeristas Negeri Semarang, Semarang, Indonesia

Nur Chayati

<https://orcid.org/0009-0005-5187-9646>

Universitas Negeri Semarang, Semarang, Indonesia

Ervina Maulida

<https://orcid.org/0000-0001-8144-4540>

Universitas Negeri Jakarta, Jakarta, Indonesia

Brillian Rosy

<https://orcid.org/0000-0001-6729-9674>

Universitas Negeri Surabaya, Surabaya, Indonesia

Abstract

Green Pedagogical Skills are essential for preparing prospective teachers to act as agents of Education for Sustainable Development (ESD). However, previous studies tend to be fragmented, focusing on individual (psychological–pedagogical) or structural factors. This research analyzes the factors influencing GPS among 369 pre-service teachers (PSTs) who have completed teaching practice, using Partial Least Squares Structural Equation Modeling (PLS-SEM). The result shows the strong predictive model (R^2 GPS = 0.795) with environmental awareness (EA) as the dominant predictor. Teaching readiness (TR) not only had a direct effect on GPS but also increased green self-efficacy (SE). Then, structural support (SS) had a dual effect: it strengthened GPS directly but weakened the EA-GPS relationship through negative moderation. The research concludes that GPS development

requires integrating a holistic approach, strengthening individual capacity (knowledge–mindset–readiness), and designing context-based structural policies. The findings indicate that it is not enough to develop PSTs' GPS by improving their environmental awareness; it also requires structural supports, their teaching readiness, and green self-efficacy in the curriculum.

Keywords: Environmental awareness, green pedagogical skills, structural support, sustainable education, teaching readiness.

Introduction

The growing number of crises facing the earth, and their underlying drivers such as climate change and biodiversity loss, highlight the need for a new narrative that promotes a sustainable future (Intergovernmental Panel on Climate Change [IPCC], 2023). Education for Sustainable Development (ESD) has been increasingly recognized as an urgent framework for equipping people with the competencies needed to address emerging multidimensional challenges (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020b). In this sense, the teacher is considered one of the crucial agents of change, responsible for conveying messages and acting in a manner that, beyond passing on knowledge, establishes values, thinking patterns, and lifestyle habits in the next generation (Ferreira et al., 2019). The success of ESD ultimately depends on its instructors' capacity to use Green Pedagogical Skills (GPS) as “skills for embedding sustainability meaningfully within teaching and learning” (Boeve de Pauw & Van Petegen, 2018).

The system education for pre-service teachers (PSTs) aims to develop these capacities, as PSTs need to be environmentally aware (EA), have a disposition toward a sustainability mindset (SM), and demonstrate teaching preparedness (TR), which will enable them to implement such practices effectively within the classroom (Tilbury, 2011). However, there is often a significant disconnect between what we know and how we teach. Tusyanah et al. (2023) conducted a study at Universitas Negeri Semarang (UNNES). They found that 82% of PSTs were concerned about environmental issues but could not develop classroom learning activities that integrated sustainability practices (Tusyanah et al., 2023). Organisation for Economic Co-operation and Development/ OECD (2023) has also noted that only a minority of teachers are prepared to teach sustainability, a finding that is more true in developing countries. This discrepancy indicates that GPS is not a linear construct but a complex, multidimensional phenomenon occurring within an educational context. Its elements of teaching readiness (Darling-Hammond et al., 2017), self-efficacy (Bandura, 1997), and a sustainability mindset (Wiek et al., 2015) have typically been studied separately in previous research.

Developing one important aspect of Pedagogical Content Knowledge of Sustainability (PCKS) was originally proposed by Saiful and Setyorini (2022), who showed how certain curricular experiences can influence pre-service teachers' ability to teach about sustainability topics. Based on this pedagogical paradigm, a complementary stream of research has gradually shifted toward individual psychological traits that underlie these

skills. For example, in a recent study (Vukelić et al., 2025) using structural equation modeling (SEM), it was found that self-efficacy was an important mechanism by which student teachers translated their values and beliefs into ESD implementation intentions. Then, Anđić and Vorkapić (2017) also indicated that teachers' environmentally responsible reflections and personal responsibility created the foundation of their sustainable-oriented dispositions. Moreover, Cortázar et al. (2025) expanded this area by proving that awareness is not only passive cognition but an active initial motive for sustainable behaviors. In line with these findings, the work by Saglik et al. (2025) shows that sustainability mindsets can be domain-specific, thereby promoting an understanding of the radical attitudinal components that can inform green pedagogy (García-González et al., 2022).

The institutional context of TR has then been identified as an important structural factor. Sharma and Singh (2019), who framed their analysis from multiple perspectives of teacher educators in India, argued that ESD needed genuine integration that could not be achieved without a complete shift in teacher education programs. It was a plea that called attention to the role of SS as the foundational tool that enables or hinders the competencies in green pedagogies. The influence of SS beyond these psychological and pedagogical factors (which include institutional policies, curriculum resources, and mentorship) is also essential to consider. However, it has been insufficiently investigated alongside these dimensions. Incompatible findings suggest that too much support can sometimes stifle personal motivation (Ross & Mirowsky, 2006).

The present study is grounded in Mezirow's (2000) Transformative Learning Theory as the grand theory. This theoretical way of seeing the world is particularly useful for ESD objectives, as it provides a clear picture of the type of inner change pre-service teachers undergo – from a passive understanding of environmental issues to becoming agents of change (Sterling, 2021). Transformative learning is the examination of assumptions, resulting in new perspectives and action (Kitchenham, 2004). This framework provides a unified view in which structural supports are examined for their role in supporting the critical purposes and dispositional changes that link environmental awareness and a sustainability mindset to the development of strong teaching readiness for green pedagogy in this study.

This study aims to integrate fragmented analyses and test a holistic model. This study has the objectives: (1) to analyze the direct effect of environmental awareness, sustainability mindset, teaching readiness, and self-efficacy on the green pedagogical skills (GPS) of pre-service teacher students; (2) to examine the moderating role of structural support in the relationship between environmental awareness and GPS; (3) to identify the dominant predictor among these four factors. To achieve these objectives, this study answers four questions: (1) Do the four individual factors significantly influence GPS? (2) How large is the magnitude of each influence? (3) Does structural support significantly moderate the relationship between environmental awareness and GPS? (4) Which factor is the most dominant? By adopting a transformative lens, we hope to move toward a more nuanced appreciation of what is needed to successfully develop and govern green pedagogical capacities that are crucial for promoting the holistic vision underlying ESD.

Literature Review

Green Pedagogical Skills in the Context of Education for Sustainable Education

Green Pedagogical Skills involve the ability of teachers to plan, implement, and assess learning in terms of aspects focusing on ecological sustainability, social justice, and environmental literacy (Hindhede, 2024; Mogren et al., 2024; Vesterinen, 2023). Yang et al. (2024) demonstrate that GPS entails both mastering environmental content and nurturing students' systems thinking, both necessary for grasping human–environment interdependence. For instance, studies by Yang et al. (2024) among 1,200 HS teachers in Southeast Asia found that teachers with a high level of GPS tended to adopt a place-based learning pedagogy that connects local issues (e.g., deforestation) with global consequences. It is consistent with UNESCO's (2024) *Greening Curriculum Guidance*, which underscores that the integration of transformative, place-based pedagogies for climate action serves as a key indicator of quality education in the 21st century.

The Transformative Learning Theory of Mezirow (2000) is seen as a critical support for building a theoretical understanding of the growth process of GPS. This theory suggests the idea that transformative learning takes place through reflection on critical assumptions and values – held up for inspection, followed by perspective transformation and ultimately action (Kitchenham, 2004). This process involves not only cognitive but also affective and behavioral aspects. In the context of green pedagogy, this critical reflection encourages prospective teachers to question the anthropocentric paradigm and adopt an ecocentric approach oriented toward sustainability (Avsec & Savec, 2021; Kopnina & Bedford, 2024; Sterling, 2021; Tsevreni & Magos, 2024;).

Within this critical theoretical framework, GPS is conceptualized as the integrated capacity to plan, enact, and assess learning, with a focus on establishing ecological literacy (Mogren et al., 2024). It is beyond content delivery; educators should support students as learners not only to understand but also to appreciate the interdisciplinary challenges posed by the interconnectedness of human and environmental systems. Teachers with strong GPS in Southeast Asia reportedly often use place-based learning approaches by introducing local issues such as deforestation to serve as a “disorientating dilemma” that disrupts students' assumptions and prompts critical reflection (Yang et al., 2024; UNESCO, 2024). Thus, for teachers, GPS is the purest form of transformative learning, providing them with the skills to guide their students through similar processes.

GPS Predictors: Integration of Individual and Structural Factors into Teaching Readiness

Teaching readiness (TR) in the context of GPS refers to PSTs' readiness to design sustainability-based learning, including mastery of green technologies and participatory methods (Huang et al., 2023). In a comparative study in Norway and Indonesia, Suryadi et al. (2019) found that TR was influenced by the availability of green curriculum tools ($\beta = 0.42$, $p < 0.01$) and environmental case-based microteaching training ($\beta = 0.38$, $p < 0.05$). It means that PSTs should be ready for teaching, as it influences their GPS in the classroom.

The second construct is Sustainability Mindset (SM), defined as a mindset that emphasizes ecological balance, intergenerational justice, and collective responsibility (Rimanozy et al., 2023). The meta-analysis by Li et al. (2023) of 45 studies found a strong correlation between SM and green pedagogical practices ($r = 0.67$, $p < 0.001$). Still, it did not explore how SM increased environmental awareness (EA). This research addresses this issue by testing the effect of SM on GPS through EA.

The first mediating variable is green self-efficacy (SE), which refers to teachers' confidence in overcoming the challenges of implementing sustainable learning (Ghazali et al., 2024; Huang et al., 2023; Karvonen et al., 2023). A longitudinal study in Australia by Smith et al. (2008) proved that green SE was influenced by environmental project-based field experience ($\beta = 0.55$, $p < 0.001$) but did not test the moderation of structural support (SS) as a key aspect in the context of developing countries.

Then, environmental awareness is the second mediating variable, referring to an individual's understanding of environmental issues (i.e., how they perceive the impact of internal and external factors on the ecosystem). It leads them to behave responsibly towards the environment around them. Nurhidayah et al. (2024) found that EA is positively correlated with GPS ($\beta = 0.61$, $p < 0.001$), but weakens when teachers rely on institutional instant modules ($\beta = -0.18$, $p < 0.05$). It is a phenomenon tested as a moderating effect of Structural Support in this study.

The moderating variable is structural support (SS), which includes institutional policies, green budget allocation, and stakeholder collaboration (UNESCO, 2020b). A case study in Vietnam showed that SS increased green pedagogical innovation ($\beta = 0.29$, $p < 0.01$) but reduced teachers' motivation to develop independent content ($\beta = -0.14$, $p < 0.05$) (Ross & Mirowsky, 2006).

Based on the above description, Table 1 presents the research gaps per variable.

Table 1
Summary of Previous Research Findings per Key Variable

No	Variable	Key Findings from Previous Research	Sources
1	Teaching Readiness (TR)	TR is influenced by the availability of a green curriculum ($\beta = 0.42$) and micro-teaching training based on environmental cases ($\beta = 0.38$).	Huang et al., 2023; Suryadi et al., 2019
2	Sustainability Mindset (SM)	A meta-analysis of 45 studies found a strong correlation between SM and green pedagogical practices ($r = 0.67$). However, it has not examined how SM enhances environmental awareness (EA).	Li et al., 2023; Rimanozy et al., 2023
3	Self-Efficacy (SE)	Green SE is influenced by field experience based on environmental projects ($\beta = 0.55$). The moderating role of structural support in developing countries has not been tested.	Ghazali et al., 2024; Huang et al., 2023; Karvonen et al., 2023; Smith et al., 2008

See next page for continuation of table

Continuation of Table 1

No	Variable	Key Findings from Previous Research	Sources
4	Environmental Awareness (EA)	EA correlates with GPS ($\beta = 0.61$), but weakens when teachers rely on the institution's instant modules ($\beta = -0.18$).	Nurhidayah et al., 2024
5	Structural Support (SS)	SS increases green pedagogical innovation ($\beta = 0.29$), but reduces teachers' motivation to develop independent content ($\beta = -0.14$) – supporting resource substitution theory.	Ross & Mirowsky, 2006; UNESCO, 2020b

The study fills this gap by making an integrative explanatory model based on Transformative Learning Theory to comprehensively examine how these factors influence GPS prediction among pre-service teachers, thereby advancing the deeper mission of ESD.

The Methodology

The Research Design

This study adapted a quantitative survey to examine the relationships among self-efficacy, teaching readiness, environmental awareness, a sustainable mindset, and Green Pedagogical Skills, when moderated by structural support. A quantitative design was selected because it provides the best approach for testing complex hypotheses through statistical analysis (Creswell, 2018).

Population and Samples

The study population comprised 5310 seventh-semester students at UNNES who participated in a teaching practice program. To compensate for an error rate of 5%, we used the Slovin formula to determine that a minimum sample size of 369 students is required.

Data Collection

Data were collected via a Google Form questionnaire. The scale has four major segments that measure specific constructs on a 4-point Likert scale (1= Strongly Disagree to 4 = Strongly Agree). Table 2 presents the definitions and indicators for each study variable. The statements in the questionnaire are based on the indicators below.

Table 2
Definitions and Indicators of the Variables

No	Variable	Definition	Indicators	Sources
1	Green Pedagogical Skill (Y)	A set of educator competencies that integrate sustainability principles, environmental awareness, and green values into pedagogical practice, including design, implementation, and evaluation.	1. Integration of environmental content in lesson plans 2. Use of eco-friendly teaching materials and methods 3. Promotion of students' environmental responsibility 4. Critical reflection on sustainability issues 5. Facilitation of systems thinking in class 6. Modeling sustainable behaviors in teaching practice	UNESCO, 2017
2	Teaching Readiness (X1)	The extent to which a teacher is prepared cognitively, emotionally, and practically to engage in effective teaching.	1. ICT mastery 2. Curriculum knowledge 3. Classroom management skills 4. Ability to adapt teaching modes 5. Confidence in delivering content	Syaiful, 2010
3	Sustainability Mindset (X2)	A mindset characterized by concern for sustainability, including long-term thinking and care for social, economic, and environmental balance.	1. Long-term thinking 2. Systems thinking 3. Ecological concern 4. Valuing interdependence 5. Promotion of sustainable practices	Susilo & Sarkowi, 2018
4	Self-Efficacy (M1)	Belief in one's capability to organize and execute actions required to manage prospective situations in teaching.	1. Confidence in using online tools 2. Belief in handling teaching challenges 3. Confidence in achieving learning objectives 4. Belief in adapting to various learning conditions	Bandura, 1997
5	Environmental Awareness (M2)	Awareness and understanding of environmental issues leading to ecologically responsible behavior and education.	1. Understanding environmental issues 2. Integration of environmental content in teaching 3. Promoting eco-friendly habits 4. Raising student awareness	Muskania & Zulela, 2021
6	Structural Support (Z)	Institutional infrastructure, policies, and resources that support teachers in implementing green and technology-enhanced pedagogical practices.	1. Access to digital platforms (e.g., MOOCs) 2. Provision of internet quota 3. Availability of training 4. Administrative support for digital learning 5. Provision of environmental resources and ICT facilities	Young, 2006

Source: Processed data, 2025

Data Analysis

The analysis of data was performed in two phases:

Phase 1: Validity and Validity of the Instrument

Before testing the hypotheses, it needs to validate the validity and reliability as seen in Table 3.

Table 3

The Definitions and the Criteria per Term

The Terms	The Definitions	The Criteria
Convergent validity	The extent to which indicators within a single variable are interrelated and measure the same construct	Average Variance Extracted (AVE) > 0.5 (Hair et al., 2019).
Discriminant validity	The extent to which one variable is truly distinct from another variable (does not overlap)	Fornell-Larcker criteria and ratio HTMT ratio < 0.85 (Henseler et al., 2015)
Reliability	The level of internal consistency of the instrument (whether the measurement results are stable)	Composite Reliability (CR) > 0.7 and Cronbach's Alpha > 0.7

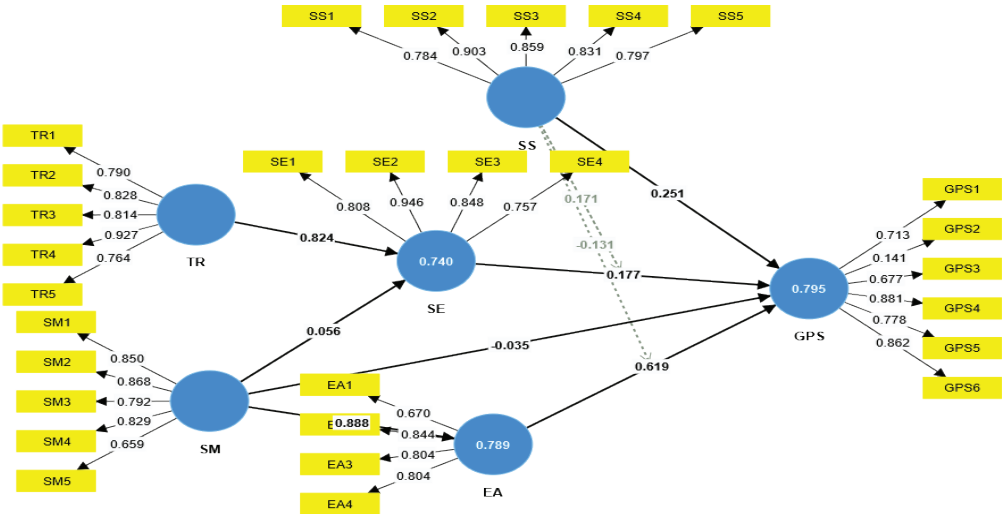
Phase 2: The Testing of Hypotheses with PLS-SEM

After the instrument was deemed valid and reliable, the researcher used PLS-SEM (Partial Least Squares Structural Equation Modeling) with SmartPLS 4.0. PLS-SEM was chosen because it is suitable for complex models and does not require strict data normality assumptions.

Model fit was assessed using three criteria: SRMR < 0.08, NFI > 0.90, and RMS_theta < 0.12 (Henseler et al., 2015). To test the moderating effect (i.e., whether structural support strengthens or weakens the relationship between variables), multi-group analysis (MGA) and bootstrap resampling with 5,000 resamples were conducted (Hair et al., 2019).

Outer Model Test (Measurement Model)

Figure 1
Outer Model Test Results



The outer model analysis (measurement model) is the initial stage in PLS-SEM, ensuring that the indicators used actually measure the latent construct's validity and reliability. The validity is evident in the loading factors for the research indicators, as shown in Table 4.

Table 4
Loading Factors

No	Variables	Indicators	Outer loadings	Threshold of convergent validity	Notes
1	Environmental Awareness	EA1 <- EA	0.670	0.7	Valid
		EA2 <- EA	0.844	0.7	Valid
		EA3 <- EA	0.804	0.7	Valid
		EA4 <- EA	0.804	0.7	Valid

See next page for continuation of table

Continuation of Table 4

No	Variables	Indicators	Outer loadings	Threshold of convergent validity	Notes
2	Green Pedagogical Skills	GPS1 <- GPS	0.713	0.7	Valid
		GPS2 <- GPS	0.141	0.7	Invalid
		GPS3 <- GPS	0.677	0.6	Valid
		GPS4 <- GPS	0.881	0.7	Valid
		GPS5 <- GPS	0.778	0.7	Valid
		GPS6 <- GPS	0.862	0.7	Valid
3	Self-Efficacy	SE1 <- SE	0.808	0.7	Valid
		SE2 <- SE	0.946	0.7	Valid
		SE3 <- SE	0.848	0.7	Valid
		SE4 <- SE	0.757	0.7	Valid
4	Sustainability Mindset	SM1 <- SM	0.850	0.7	Valid
		SM2 <- SM	0.868	0.7	Valid
		SM3 <- SM	0.792	0.7	Valid
		SM4 <- SM	0.829	0.7	Valid
		SM5 <- SM	0.659	0.6	Valid
5	Structural Support	SS1 <- SS	0.784	0.7	Valid
		SS2 <- SS	0.903	0.7	Valid
		SS3 <- SS	0.859	0.7	Valid
		SS4 <- SS	0.831	0.7	Valid
		SS5 <- SS	0.797	0.7	Valid
		TR1 <- TR	0.790	0.7	Valid
		TR2 <- TR	0.828	0.7	Valid
		TR3 <- TR	0.814	0.7	Valid
6	Teaching Readiness	TR4 <- TR	0.927	0.7	Valid
		TR5 <- TR	0.764	0.7	Valid

Source: Processed data, 2025

Table 4 shows that most indicators meet the 0.7 threshold, confirming strong convergent validity. While EA1 (0.668), GPS3 (0.678), and SM5 (0.638) slightly fall below, they were retained to preserve construct coverage, as only GPS2 (0.131) was removed because it was clearly invalid.

Then, AVE and CR tests validated these constructs as presented in Table 5. CR values above 0.7 confirmed the internal consistency of the constructs, and AVE scores exceeding 0.5 established satisfactory convergent validity by showing that each construct accounted for most of the variance in its indicators (Hair et al., 2019).

Table 5
Construct Reliability and Convergent Validity

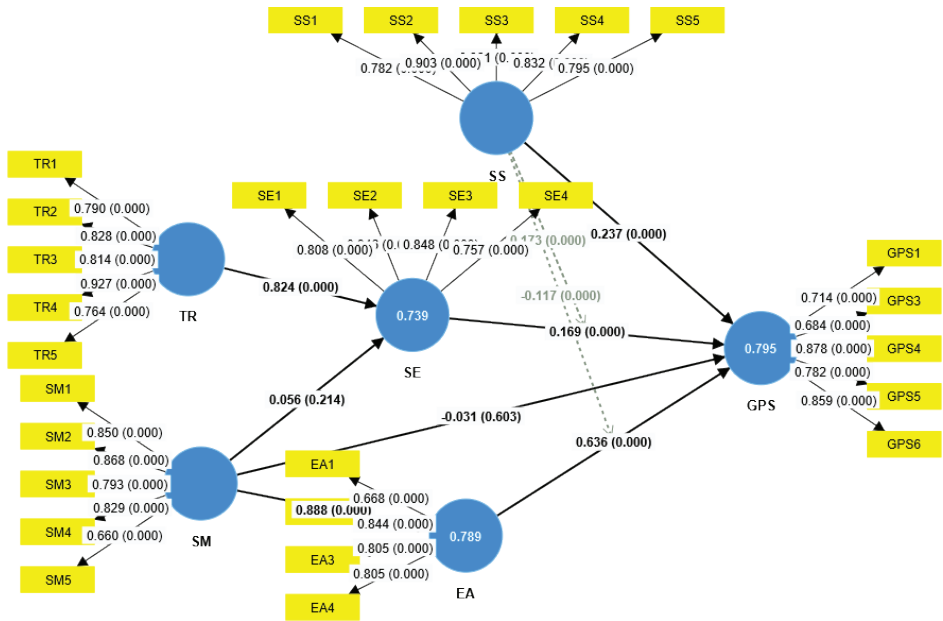
Variable	Cronbach's alpha	Threshold Cronbach's alpha	Notes	Average variance extracted (AVE)	Threshold of AVE	Notes
EA	0.787	0.700	Reliable	0.614	0.5	Valid
GPS	0.779	0.700	Reliable	0.519	0.5	Valid
SE	0.862	0.700	Reliable	0.710	0.5	Valid
SM	0.860	0.700	Reliable	0.645	0.5	Valid
SS	0.892	0.700	Reliable	0.699	0.5	Valid
TR	0.883	0.700	Reliable	0.683	0.5	Valid

Source: Processed data, 2025

Table 5 shows that all constructs in this study demonstrate reliability and convergent validity for use in the structural model.

Inner Model Test (Structural Model)

Figure 2
Inner Model Test Results



The analysis of the inner model (structural model) in PLS-SEM aimed to test the causal relationship between constructs based on the research hypothesis. Table 6 evaluates the magnitude and significance of the relationships among latent variables via path coefficients (β), showing the direct and indirect effects of the variables.

Table 6
Path Coefficient

The effects	Original sample (O)	Sample mean (M)	ST-DEV	T statistics (O/STDEV)	P values	Hypotheses	Notes
EA -> GPS	0.636	0.638	0.060	10.538	0.000	H1	Accepted
SE -> GPS	0.169	0.167	0.040	4.180	0.000	H2	Accepted
SM -> EA	0.888	0.888	0.013	66.861	0.000	H3	Accepted
SM -> GPS	0.544	0.546	0.037	14.575	0.000	H4	Accepted
SM -> SE	0.056	0.059	0.045	1.243	0.214	H5	Rejected
SS -> GPS	0.237	0.237	0.037	6.483	0.000	H6	Accepted
TR -> GPS	0.139	0.137	0.034	4.094	0.000	H7	Accepted
TR -> SE	0.824	0.821	0.037	22.097	0.000	H8	Accepted
SS x SE -> GPS	0.173	0.170	0.038	4.508	0.000	H9	Accepted
SS x EA -> GPS	-0.117	-0.115	0.032	3.723	0.000	H10	Rejected

Source: The primary processed data, 2025

Several important findings emerged from the quantitative analysis of the structural model, as shown in Table 6. Environmental Awareness has a significant effect on GPS and is the variable with the largest direct effect (path coefficient = 0.636; $p < 0.001$), meaning that an increase of one unit in EA will cause an equivalent increase by 63.6% in GPS. The magnitude of the difference ($t = 10.538$) indicated that environmental content mastery is a major antecedent of the propagation of green pedagogy.

Sustainability Mindset shows a significant dual effect. Against EA, SM has a coefficient of 0.888 ($p < 0.001$; $t = 66.861$); this is a strong effect revealing the fundamental role of sustainability values in shaping environmental awareness. Meanwhile, for GPS, the direct effect of SM remains significant although more moderate ($\beta = 0.544$; $p < 0.001$; $t = 14.575$), suggesting that a sustainable mindset makes a unique contribution beyond that mediated through EA.

The moderation analysis reveals the complexity of SS's role. The SSxSE interaction effect on GPS is significantly positive ($\beta = 0.173$; $p < 0.001$; $t = 4.508$), indicating that institutional support strengthens the relationship between self-efficacy and pedagogical

skills. Interestingly, however, the moderation effect of SSxEA was adverse ($\beta = -0.117$; $p < 0.001$; $t = 3.723$), indicating that in an environment with adequate support, reliance on individual knowledge might be reduced.

TR showed a significant influence both on GPS ($\beta = 0.139$; $p < 0.001$; $t = 4.094$) and on SE ($\beta = 0.824$; $p < 0.001$; $t = 22.097$). The magnitude of the TR-SE coefficient indicates that their teaching readiness accounts for 82.4% of the variation in teachers' self-efficacy. This finding confirms the importance of basic teaching skills.

What is noteworthy is the non-significance of the SM-SE relationship ($\beta = 0.056$; $p = 0.214$; $t = 1.243$) – a finding that was consistent despite bootstrapping with 5000 subsamples. The p -value > 0.05 and the t -statistic < 1.96 convincingly show that a sustainability mindset does not directly influence pedagogical self-efficacy but rather operates through other mechanisms, such as increasing environmental awareness.

Then, within the inner model, the model's predictive performance is measured by the R^2 (determination coefficient). It shows the relationship between latent variables and the theory evaluated by the dependent construct. Based on the criteria proposed by Hair et al. (2019), the predictive accuracy of the model is categorized into three levels: 0.75 indicates a strong model, 0.50 a moderate model, and 0.25 a weak model. This classification provides an overview of the extent to which the developed structural model possesses adequate predictive relevance. The higher the R-Square (R^2) value, the better the construct. Table 7 shows the R-Square (R^2) results.

Table 7
R-square

Variables	R-square	R-square adjusted	Notes
GPS	0.795	0.792	Strong
EA	0.789	0.788	Strong
SE	0.740	0.738	Strong

Source: Processed data, 2025

The research model, as shown in Table 7, has excellent predictive power; for the GPS variable, the R-square value is 0.795, indicating that the combination of EA, SE, SM, SS, and TR can predict 79.5% of GPS variance. The adjusted R-square value (0.792) remains high, confirming that the model's predictive power remains strong even after adjusting for the number of predictors. The predictive relevance of the model was also assessed using Stone-Geisser's Q^2 (predictive relevance), as shown in Table 8.

Table 8
The Predictive Relevance

The Effects	f-square	Notes
EA -> GPS	0.328	Medium effect
SE -> GPS	0.060	Small effect
SM -> EA	3.735	Large effect
SM -> GPS	0.001	No effect
SM -> SE	0.007	No effect
SS -> GPS	0.119	Small effect
TR -> SE	1.589	Large effect
SS x EA -> GPS	0.031	Small effect
SS x SE -> GPS	0.051	Small effect

Source: Processed data, 2025

The effect size analysis (see Table 8) reveals that SM has a considerable influence on EA, with an F-squared value of 3.735, indicating that SM is the dominant factor shaping EA. Then, A has a moderate effect on GPS (f-square = 0.328), showing that environmental understanding is significantly modified, though to a lesser extent than SM's influence on EA. In contrast, SS and SE have only slight effects on GPS (f-squares of 0.119 and 0.060, respectively), indicating a modest contribution.

Discussion

GPS constitutes a critical competency in responding to global environmental challenges such as the climate crisis, deforestation, and pollution. The sequence of dominant predictors that influence GPS: Environmental awareness (EA) ($\beta = 0.636$; $p < 0.001$), sustainability mindset (SM) ($\beta = 0.544$; $p < 0.001$), structural support (SS) ($\beta = 0.237$; $p < 0.001$), teaching readiness (TR) ($\beta = 0.139$; $p < 0.001$), and self-efficacy (SE) ($\beta = 0.169$; $p < 0.001$).

These results are consistent with findings from Germany (Rieckmann, 2018) that identify EA and SM as drivers of a green pedagogical shift.

Of ten hypotheses tested, eight were supported (H1–H4, H6–H9) and two were rejected (H5, H10). The confirmatory hypotheses are that EA, SM, SS, TR, and SE have direct effects on GPS, and that SS moderates the relationship between SE and GPS. On the other hand, the relationship between SM and SE (H5) and the negative moderation of SS in EA (H10) were not supported. H5 is not supported, indicating that a dispositional mindset does not form pedagogical self-confidence directly. The discussion further considers each hypothesis individually.

The best predictor of GPS was EA ($\beta = 0.636$; $p < 0.001$). In South Africa, one study

reported that teachers who possessed in-depth knowledge of the climate crisis were 2.3 times more likely to develop environmentally oriented learning if they adopted EA due to its ability to connect theory with concrete contexts, such as the contribution of deforestation to the negative impact on communities (Mugambi & Okech, 2016).

SE also has important effects, but they are less pronounced ($\beta = 0.169$; $p < 0.001$). However, the present negligible coefficient indicates that SE is insufficient without EA and SM, as also observed in Mexico (Garcia et al., 2021), where environmental contentless technical training did not yield an improvement in GPS due to teachers' conceptual inadequacy. A combined SE strengthening and workshop-based EA training program improved GPS by 1.8 times more than SE.

Then, SM strongly influences EA ($\beta = 0.888$; $p < 0.001$). Research from Norway by Mogren et al. (2024) suggests that teachers with a high level of SM seek to engage students with current environmental information. These results demonstrate that SM is a fundamental mechanism for translating abstract values into practice.

Then, the direct effect of SM on GPS ($\beta = 0.544$; $p < 0.001$) aligns with Mezirow's (2000) Transformative Learning Theory, which posits that a shift from "knowing" to "acting" drives the implementation of green pedagogy. A study in India by Collins and Patel (2023) also revealed that SM increased teacher involvement in collaborative inter-school projects, such as greening campaigns, which directly strengthened GPS. Thus, SM not only influences what is taught but also how learning is designed in a participatory manner.

The absence of an SM-SE relationship ($\beta = 0.056$; $p = 0.214$) contradicts the initial assumption that a sustainable mindset automatically builds pedagogical self-confidence. According to Hobfoll's (1989) Conservation of Resources theory, SM alone may not directly lead to enhanced SE; therefore, it needs to be strengthened through practical experience. A study by Yilmaz et al. (2023) also found that pre-service teachers with high SM and low environmental teaching experience were hesitant to use environmental education, suggesting that green SE should involve guided practice.

SS had a positive effect ($\beta = 0.237$; $p < 0.001$), as reported by Tran et al. (2024) in Vietnam. However, according to Swedish researchers, Mogren et al. (2024), overly bureaucratic SS, such as complicated administrative procedures for using environmental funds, actually inhibit teacher creativity, suggesting that SS effectiveness depends on design flexibility. In a study in Kenya, Otieno and Povey (2023) proposed a "hybrid" SS model that combines national guidance with local autonomy, resulting in a 28% improvement in GPS. Thus, SS should be designed as an enabler rather than a constraint to maximize its impact.

The positive SS-SE interaction ($\beta = 0.173$; $p < 0.001$) suggests that SS strengthens the SE effect, as observed by Evans et al. (2017), who found that green school policies (e.g., campus greening) combined with teacher training increased GPS by boosting collective self-efficacy. In South Korea, a Green Mentorship program, in which experienced teachers guided juniors in using green facilities, increased SE by 22% (Lee et al., 2023). This finding is consistent with Bronfenbrenner's (1979) ecological systems theory, which holds that the macro (SS) and micro (SE) environments interact to promote change. Thus, SS should be designed to create an ecosystem that strengthens individual capacity.

The negative moderation of SS-EA ($\beta = -0.117$; $p < 0.001$) confirms Ross & Mirowsky's Resource Substitution theory (2006): Overly structured SS (e.g., instant modules) reduces teachers' incentives to develop independent EA. Teachers who receive ready-to-use green curriculum modules from the education department tend not to explore local issues because they feel there is no need to look into them from the bottom up. It indicates that teachers committed to environmental education must actively work against structural constraints and "go against the grain" of the existing system in order to develop authentic, context-based green pedagogical practices (Gandolfi, 2024). In other words, excessive structural support in the form of overly scripted curricula can weaken teachers' intrinsic motivation to conduct independent exploration of local issues. A study in India by Collins and Patel (2023) also found that top-down-based SS decreased teacher participation in EA training by 15%. To avoid this paradox, SS should be designed through co-creation, involving teachers in the development of materials so they continue to spark critical curiosity. It means that developing the GPS cannot be reduced to partial efforts but requires synergistic integration between strengthening individual capacity and structural transformation. The study not only modifies the empirical understanding of how EA, SM, SS, TR, and SE shape GPS but also resonates with our own lived experiences as PST educators.

In day-to-day dealings with PSTs, we noted that the majority were already aware of sustainability, especially in garbage disposal. They made a conscious effort to minimize single-use plastics, engaged in campus recycling programs, and genuinely demonstrated enthusiasm for anything green or green initiatives endorsed by the university, as stated by Barth and Rieckmann (2012), who identified the institutional organization as a trigger for pedagogical transformations.

Reflecting on these cases, it is notable that there is a tension between what PSTs learned in higher education and the realities they encountered during teaching practice in high schools. Although these PSTs had high levels of awareness and positive attitudes, several relapsed into unsustainable practices (e.g., paper-based teaching and assessment) during school placements. Not that they did not want to embed sustainable habits, but other contextual factors, such as the lack of digital infrastructure, the lockdown's key performance indicators, and school policy based on a centuries-old practice, were holding them back. These obstacles indicate that sustainability at school cannot be conceived of solely as an individual competence but must also receive systemic support at the school level (Marwick & Hunt, 2019). PSTs may feel unsupported, leading to dissonance between values and professional practice in the classroom and ultimately reducing confidence and commitment to sustainability (Cai et al., 2022; Huang & Wang, 2024; Kollar et al., 2005; Meyer et al., 2023).

This introspective observation reinforces the interpretation of a paradoxical structural support role identified in this study. Although support can be empowering, inflexible or misaligned frameworks can stifle creativity and agency. Support structures need to be conceived not just as mechanisms for resources, but rather as enabling environments that foster experimentation, innovation, and critical reflection. For example, the process of co-designing digital assessment capabilities with teachers might also lead to reduced paper use whilst simultaneously developing pedagogical capacity and environmental

responsibility. Such strategies can help bridge the gap highlighted previously between idealistic visions of sustainability at the tertiary education level and the implementation of sustainable development in practice at the school level (UNESCO, 2020a), posing a challenge to transformative, action-oriented learning.

In terms of ESD, these reflections emphasize the need to prepare teachers who are both environmentally literate and resilient in their efforts to innovate while grappling with contextual obstacles. The UNESCO ESD framework focuses on transformative learning that enables learners to do (UNESCO, 2020a); however, based on our field experiences, this transformation is a combination of internal capacity (awareness and mindset self-efficacy) and external support (infrastructure, policy-making, school culture). It aligns with Rieckmann (2018), who suggested that sustainability competences were both cognitive and action-based.

Aside from its theoretical framework, the study also provides some practical pointers for policy-based initiatives in teacher education. The acquisition of GPS is an iterative process involving reflection, adaptation, and practice; it is even consistent with action research principles in education (Kemmis et al., 2014).

For future studies, we suggest examining the influences of variables such as transformational leadership, green organizational culture, and cross-country policy, as they can enrich theoretical models. Publicizing these results globally was important for achieving the Sustainable Development Goals, including Goal 4.7, which promotes education for sustainable development. Therefore, the green education reform is not only about producing qualified teachers but also about establishing a learning ecosystem that enables teachers to act as change agents in addressing environmental issues in the 21st century.

Conclusion

The research has succeeded in mapping the complex dynamics that shape teachers' green pedagogical skills. The main findings confirm that sustainable educational transformation requires strengthening individual capacity (through EA, SM, and TR) and structural transformation (through SS). As structural support (SS) also had a dual effect: it directly strengthened GPS ($\beta = 0.237$; $p < 0.001$) but, paradoxically, weakened the positive relationship between EA and GPS through a negative moderation effect ($\beta = -0.117$; $p < 0.001$). If the support is not set up correctly, it might backfire, making teachers less likely to think deeply about how they teach.

Recommendations

PSTs should actively develop environmental awareness through self-directed learning and community engagement, given the era of massive information sharing through social media and the internet, which are stronger predictors of GPS. They should focus on policies that empower teachers as agents of change, rather than merely passive recipients of the system. The proposed GPS model is statistically sound and offers a general framework for analyzing the development of green pedagogical skills. By focusing

on the interrelationship between structural (institutional support) and individual factors (mindset, knowledge, and readiness), the research provides a model for sustainable educational change suited to 21st-century challenges. Then, policymakers should provide structural support (e.g., green budgeting, policies, and partnerships) and ensure that such support is empowering rather than controlling.

In the future, longitudinal studies will be needed to track this developmental course. Furthermore, qualitative research might delve deeper into pre-service teachers' lived experiences and the challenges of living in this tension. Cross-cultural and comparative studies may also be conducted, replicating the proposed GPS model across different national contexts (e.g., developing vs. developed countries, collectivist vs. individualist cultures) to test the generalizability of the dual effect of structural support.

References

- Andić, D., & Vorkapić, S. T. (2017). Teacher education for sustainability: The awareness and responsibility for sustainability problems. *Journal of Teacher Education for Sustainability*, 19(2), 121–137. <https://doi.org/10.1515/jtes-2017-0018>
- Avsec, S., & Savec, V. F. (2021). Preservice teachers' perceptions of and experiences with technology-enhanced transformative learning towards education for sustainable development. *Sustainability*, 13(18), 10443. <https://doi.org/10.3390/su131810443>
- Bandura, A. (1997). *Self-efficacy - The exercise of control*. W. H. Freeman and Company.
- Barth, M., & Rieckmann, M. (2012). Academic staff development as a catalyst for curriculum change towards education for sustainable development : An output perspective. *Journal of Cleaner Production*, 26, 28–36. <https://doi.org/10.1016/j.jclepro.2011.12.011>
- Boeve de Pauw, J., & Van Petegen, P. (2018). Eco-school evaluation beyond labels: The impact of environmental policy, didactics, and nature at school on students' outcomes. *Environmental Education*, 24(9), 1250–1267. <https://doi.org/10.1080/13504622.2017130732>
- Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.
- Cai, Z., Zhu, J., & Tian, S. (2022). Preservice teachers' teaching internship affects professional identity: Self-efficacy and learning engagement as mediators. *Frontiers in Psychology*, 13, 1–9. <https://doi.org/10.3389/fpsyg.2022.1070763>
- Collins, M., & Patel, R. (2023). Crisis management in personal branding: Lessons from PR practice. *Corporate Communications*, 28(4), 445–462.
- Cortázar, L. O., Mahecha, C. S., & Vinasco, J. B. (2025). Beyond sustainability knowledge: How awareness drives sustainable actions. *Journal of Teacher Education for Sustainability*, 27(2), 83–100. <https://doi.org/10.2478/jtes-2025-0020>
- Creswell, J. W. (2018). Planning, conducting, and evaluating quantitative and qualitative research. University of Nebraska.
- Darling-Hammond, L., Schopp, M., & Minnich, C. (2017). *Developing and measuring higher order thinking skills: Model for state performance assessment systems*. Learning Policy Institute and Council of Chief State School Officers.

- Evans, N. J., Phua, J., Lim, J., & Jun, H. (2017). Disclosing Instagram influencer advertising: The effects of disclosure language on advertising recognition, attitudes, and behavioral intent. *Journal of Interactive Advertising*, 17(2), 138–149. <https://doi.org/10.1080/15252019.2017.1366885>
- Ferreira, J. A., Vans, N., Davis, J. M., Stevenson, R., & Evans, N. (2019). Teacher education and education for sustainability. *Learning to Embed Sustainability in Teacher Education*, 7–21. https://doi.org/10.1007/978-981-13-536-9_2
- García-González, E., Albareda-Tiana, S., Solís-Espallargas, C., & Jiménez-Fontana, R. (2022). Transformative education for sustainable consumption. *Trends in Higher Education*, 1, 1–15. <https://doi.org/10.3390/higheredu1010001>
- Garcia, M., Torres, E., & Martinez, L. (2021). Bridging the gap: Academic community partnership for sustainable development. *Sustainable Development*, 29(2), 234–246.
- Gandolfi, H. E. (2024). Teaching in the age of environmental emergencies: A “utopian” exploration of the experiences of teachers committed to environmental education in England. *Educational Review*, 76(7), 1786–1806. <https://doi.org/10.1080/00131911.2022.2163378>
- Ghazali, M., Makrakis, V., Kostoulas-Makrakis, N., Yakob, N., Rashid, R. A. A., Othman, W., & Fitriyanto, N. A. (2024). Predicting tea herders’ information and communication technology-enabled education for sustainability self-efficacy. *Sustainability*, 16(13), 523. <https://doi.org/10.3390/su16135323>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). *Partial least squares structural equation modeling (PLS-SEM)*. Sage Publications.
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
- Hindhede, K. (2024). Integrating ecojustice pedagogy with social justice pedagogy in children’s literature courses. *Curriculum and Teaching Studies*, 11(1), 1–18. <https://doi.org/10.1080/2331186X.2024.234437>
- Hobfoll, S. E. (1989). Conservation of resources: A new attempt at conceptualizing stress. *American Psychologist*, 44(3), 513–524. <https://doi.org/10.1037/0003-066X.44.3.513>
- Huang, L., Zhang, H., Si, H., & Wang, H. (2023). Can the digital economy promote urban green economic efficiency? Evidence from 273 cities in China. *Ecological Indicators*, 155(11), 1–30. <https://doi.org/10.1016/j.ecol.2023.110977>
- Huang, X. Y., & Wang, C. (2024). Preservice teachers’ professional identity transformation: A positioning theory perspective. *Professional Development in Education*, 50(1), 174–191. <https://doi.org/10.1080/19415257.2021.1942143>
- Intergovernmental Panel on Climate Change. *Climate change 2022 – Impacts, adaptation and vulnerability: Working group II contribution to the sixth assessment report of the intergovernmental panel on climate change*. Cambridge University Press. <https://doi.org/10.1017/9781009325844>
- Karvonen, R., Ratinen, I., & Kemi, U. (2023). Promoting sustainability competency and self-efficacy in teacher education. *Frontiers in Sustainability*, 4, 1–10. <https://doi.org/10.3389/frsus.2023.1205680>

- Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Going critical participatory action research*. Springer. <https://doi.org/10.1007/978-981-4560-67-2>
- Kitchenham, B. (2004). *Procedures for performing systematic reviews*. Keele University.
- Kollar, I., Fischer, F., & Slotta, J. D. (2005). Internal and external collaboration scripts in web-based science learning at schools. In T. Koschmann, D. Suthers, & T.-W. Chan (Eds.), *Proceedings of the 2005 conference on Computer support for collaborative learning: Learning 2005: The next 10 years!* (pp. 331–340). International Society of the Learning Sciences.
- Kopnina, H., & Bedford, T. (2024). From pseudo to genuine sustainability education: Ecopedagogy and degrowth in business studies courses. *Australian Journal of Environmental Education* 40(3), 574–587. <https://doi.org/10.1017/ae.2023.39>
- Lee, C.-C., He, Z.-W., & Yuan, Z. (2023). A pathway to sustainable development: Digitization and green productivity. *Energy Economics*, 123(8), 106772. <https://doi.org/10.1016/j.eneco.2023.106772>
- Li, T.-T., Wang, K., Sueyoshi, T., & Wang, D. D. (2023). ESG: Research progress and future prospect. *Sustainability*, 13(1163), 1–28. https://doi.org/10.3920/978-90-8686-523-9_00
- Marwick, P., & Hunt, C. (2019). Transforming education for sustainable futures: The role of education systems, schools and teachers. *International Journal of Educational Development*, 70(102077). <https://doi.org/10.1016/j.ijedudev.2019.10277>
- Meyer, D., Doll, J., & Kaiser, G. (2023). Professional identity of preservice teachers: Actual and designated identity profiles and their relationship to teacher education programs. *Frontiers in Education*, 8, 1–11. <https://doi.org/10.3389/feduc.2023.1134848>
- Mezirow, J. (2000). *How Critical Reflection Triggers Transformative Learning*. Jossey-Bass.
- Mogren, A., Seiser, A., Gericke, N., Berglund, T., & Olsson, D. (2024). Leadership actions that enable or constrain the accommodation of education for sustainable development. *International Journal of Leadership in Education*, 1–30. <https://doi.org/10.1080/13603124.2024.2418623>
- Mugambi, M., & Okech, T. C. (2016). Effect of macroeconomic variables on stock returns of listed commercial banks in Kenya. *International Journal of Economics, Commerce and Management*, 390–41.
- Muskania, R., & Zulela, MS. (2021). Realita transformasi digital pendidikan di sekolah dasar selama pandemi COVID-19 [The reality of digital transformation in elementary education during the COVID-19 pandemic]. *Jurnal Pendidikan Dasar Nusantara*, 6(2), 155–165. <https://doi.org/10.29407/jpdpn.v6i2.15298>
- Nurhidayah, N., Buhungo, T. J., & Setiawan, D. G. E. (2024). Penerapan model pembelajaran probing prompting untuk meningkatkan hasil belajar siswa pada materi suhu dan kalor di SMA Negeri 4 Kota Gorontalo [Application of the probing prompting learning model to improve student learning outcomes on temperature and heat material in SMA Negeri 4 Kota Gorontalo]. *Jurnal Jendela Pendidikan*, 4(3), 310–321. <https://www.ejournal.jendelaedukasi.id/index.php/JJP>
- Organisation for Economic Co-operation and Development. (2023). *PISA 2022 results: The state of learning and equity in education*. OECD Publishing. <https://doi.org/10.1787/53f23881-en>

- Otieno, H., & Povey, H. (2023). Mathematics textbooks and self-regulated learning: Responses from students in three Kenyan secondary schools. *Research in Mathematics Education*, 25(3), 342–358. <https://doi.org/10.1080/14794802.2022.2089907>
- Rieckmann, M. (2018). Learning to transform the world: Key competencies in education for sustainable development. In A. Leicht, J. Heiss, & W. J. Byun (Eds.), *Issues and trends in education for sustainable development* (pp. 39-59). UNESCO Publishing.
- Rimanozy, I., Kassel, K., & Mitchell, S. (2023). The sustainable mindset: Connecting being, thinking, and doing in management education. *Academy of Management Proceedings*. <https://doi.org/.5465/A BPP.2023.16659abstract>
- Ross, C. E., & Mirowsky, J. (2006). *Social cause of psychological distress*. Aldine de Ruyter.
- Saglik, Z., Gurkan, G., & Kahraman, S. (2025). Permaculture as a system for sustainable life: Attitudes of prospective science teachers from Eastern Anatolia (Turkey). *Journal of Teacher Education for Sustainability*, 27(1), 135–156. <https://doi.org/10.2478/jtes-2025-0008>
- Saiful, J. A., & Setyorini, A. (2022). Ecocriticism course: Development of English preservice teachers' pedagogical content knowledge of sustainability. *Journal of Teacher Education for Sustainability*, 24(2), 5–18. <https://doi.org/10.2478/jtes-2022-0013>
- Sharma, M. J., & Singh, N. S. (2019). An analytical study based on the perspectives of teacher educators in India regarding education for sustainable development. *Journal of Teacher Education for Sustainability*, 21(2), 38–55. <https://doi.org/10.2478/jtes-2019-0016>
- Smith, J. R, Terry, D. J., Manstead, A. S. R., Louis, W. R., Kotterman, D., & Wolfs, J. (2008). The attitude-behavior relationship in consumer conduct: The role of norms, past behavior, and self-identity. *Journal of Social Psychology*, 148(3), 311–334. <https://doi.org/10.3200/SOCP.148.3.311-334>
- Sterling, S. (2021). Concern, conception, and consequence: Re-thinking the paradigm of higher education in dangerous times. *Frontiers in Sustainability*, 2, 1–13. <https://doi.org/10.3389/frsus.2021.743806>
- Suryadi, B., Rahmawati, Y., Hayat, B., & Suprananto, S. (2019). Indonesian national curriculum reform in the context of standards-based education: Policy and implementation. *TARBIYA: Journal of Education in Muslim Society*, 6(1), 76–87. <https://doi.org/10.15408/tjems.v6i1.12883>
- Susilo, A., & Sarkowi, S. (2018). Peran guru sejarah abad 21 dalam menghadapi tantangan arus globalisasi [The role of 21st century history teachers in facing the challenges of globalization]. *Historia: Jurnal Pendidik dan Peneliti Sejarah*, 2(1), 43. <https://doi.org/10.17509/historia.v2i1.11206>
- Syaiful, S. (2010). *Konsep dan Makna Pembelajaran [The Concept and Meaning of Learning]*. Alfabeta.
- Tilbury, D. (2011). *Education for sustainable development: An expert review of processes and learning*. UNESCO. (ED.2010/WS/46). <https://unesdoc.unesco.org/ark:/48223/pf0000191442>
- Tran, L. T., Wardle, H., Colledge-Frisby, S., Taylor, S., Lynch, M., Rehm, J., Volberg, R., Marionneau, V., Saxena, S., Bunn, C., Farrell, M., & Degenhardt, L. (2024). The prevalence of gambling and problematic gambling: a systematic review and

- meta-analysis. *The Lancet Public Health*, 9(8), e594–e613. [https://doi.org/10.1016/S2468-2667\(24\)00126-9](https://doi.org/10.1016/S2468-2667(24)00126-9)
- Tsevreñi, I., & Magos, K. (2024). Experiential environmental learning together with the trees in the Anthropocene. *Interdisciplinary Journal of Environmental and Science Education*, 20(2), e2024. <https://doi.org/10.29333/ijese/14365>
- Tusyanah, T., Ismiyati, I., Suryanto, E., & Susilowati, N. (2023). Does green space signify on students' academic performance and pro-environmental behavior? An empirical study at a pro-environmental university. *Journal of STEAM Education*, 6(1), 84–100. <https://doi.org/10.55290/steam.1149958>
- United Nations Educational, Scientific, and Cultural Organization. (2017). *Education for Sustainable Development Goals: Learning Objectives*. UNESCO Publishing. <https://doi.org/10.54675/CGBA9153>
- United Nations Educational, Scientific, and Cultural Organization. (2020a). *Education for Sustainable Development: A roadmap*. UNESCO Publishing. <https://doi.org/10.54675/YFRE1448>
- United Nations Educational, Scientific, and Cultural Organization. (2020b). *Build Back Better: Education must change after COVID-19 to meet the climate crisis*. UNESCO Publishing. <https://unesdoc.unesco.org/ark:/48223/pf0000373467>
- United Nations Educational, Scientific, and Cultural Organization. (2024). *Greening curriculum guidance: Teaching and learning for climate action*. UNESCO Publishing. <https://unesdoc.unesco.org/ark:/48223/pf0000390022>
- Vesterinen, M. (2023). Sustainability competences in environmental education: Guidebooks for teachers at Finnish primary schools. *Cogent Education*, 11(1), 1–39. <https://doi.org/10.1080/2331186X.2023.2286120>
- Vukelić, N., Lončarić, D., & Rončević, N. (2025). Predicting student teachers' ESD implementation intention : The role of values, beliefs, attitudes, and self-efficacy. *Journal of Teacher Education for Sustainability*, 27(1), 33–56. <https://doi.org/10.2478/jtes-2025-0003>
- Wiek, A., Bernstein, M. J., Foley, R. W., Cohen, M., Forrest, N., Kuzdas, C., Kay, B., & Keeler, L. W. (2015). Operationalising competencies in higher education for sustainable development. In M. Barth, G. Michelsen, M. Rieckmann, & I. Thomas (Eds.), *Routledge Handbook of Higher Education for Sustainable Development* (pp. 241–260). Routledge. <https://doi.org/10.4324/9781315852249-20>
- Yang, W., Chinedu, C. C., Chen, W., Saleem, A., Ogunniran, M. O., Ñacato Estrella, D. R., & Vaca Barahona, B. (2024). Building capacity for sustainability education: An analysis of vocational teachers' knowledge, readiness, and self-efficacy. *Sustainability*, 16(9), 3535. <https://doi.org/10.3390/su16093535>
- Yilmaz R., Sulak, S., Griffiths, M. D., & F. G. K. (2023). An exploratory study of the relationship between internet gaming disorder, smartphone addictions, social appearance anxiety, and aggression among undergraduate students. *Journal of Affective Disorders Reports*, 14, 100483 <https://doi.org/10.1016/j.jadr.2023.100483>
- Young, M. J. D. (2006). Social support and life satisfaction. *International Journal of Psychosocial Rehabilitation*, 10(2), 155–164.

Correspondence concerning this paper should be addressed to Tusyanah Tusyanah, Universitas Negeri Semarang, Sekaran, Gunungpati, Semarang, Central Java, 50229, Indonesia. Email: tusyanah@mail.unnes.ac.id