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Generative AI-Enabled Environmental Education and Green Entrepreneurial Intention

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ABSTRACT

Environmental education increasingly requires digital learning approaches that help students understand environmental problems and develop sustainability-oriented responses. This study examines how generative AI adoption (GAA) contributes to this educational process by supporting green skills, green opportunity recognition, and green entrepreneurial intention (GEI) among university students in Vietnam. Drawing on human capital theory, opportunity recognition theory, and person–environment fit theory, the study proposes a model in which green skills (GS) and green opportunity recognition (GOR) serve as mediators, while sustainable entrepreneurship education (SEE) acts as a moderator. Data were collected from 599 university students with experience using generative AI tools and analyzed using partial least squares structural equation modeling (PLS-SEM). The findings show that GAA is positively associated with GS and GOR. GS is positively associated with GOR and GEI, while GOR is positively associated with GEI. The mediation results confirm that GS and GOR explain how GAA is linked to GEI. In addition, SEE strengthens the GS–GOR and GOR–GEI relationships. These findings contribute to environmental education and sustainability research by identifying a capability-to-action pathway through which AI-supported learning, green competencies, and environmental opportunity recognition jointly shape GEI. Practically, universities should embed GenAI within sustainability-oriented education to strengthen environmental problem-solving, responsible resource use, and the development of feasible green initiatives.

Keywords: *Environmental education, Generative AI adoption, Green skills, Green opportunity recognition, Sustainable entrepreneurship education, Green entrepreneurial intention*

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INTRODUCTION

In the context of climate change, resource degradation, and the increasing pressure to transition to greener development models, environmental education must help students understand environmental problems and develop sustainability-oriented responses. Green entrepreneurship (GE) offers a pathway for reconciling economic growth, environmental protection, and sustainable value creation (Gupta & Dharwal, 2022; Yi, 2021). From an environmental studies perspective, GE frames pollution, resource inefficiency, waste generation, and environmental degradation as problems requiring innovative and sustainable solutions. This role is especially important in emerging economies, where growth is often accompanied by pollution, inefficient resource use, and the need for sustainability-oriented capabilities (Alvarez-Risco *et al*., 2021; Valencia-Arias *et al*., 2025).

Previous studies have advanced the understanding of green entrepreneurial intention (GEI) and sustainable entrepreneurial intention (SEI). A major stream of research has focused on psychological and educational antecedents shaping GEI or SEI (Wang *et al*., 2021; Prabowo *et al*., 2022; Adjimah *et al*., 2025; Talukder *et al*., 2025; Valencia-Arias *et al*., 2025; Alimehmeti *et al*., 2026; Kumar *et al*., 2026). However, many studies still rely heavily on traditional intention-based models (Amankwah & Sesen, 2021; Yi, 2021; Barba-Sánchez *et al*., 2022; Ip, 2026; Kumar *et al*., 2026). More importantly, existing studies have paid limited attention to how environmental education helps students interpret ecological problems, evaluate sustainable alternatives, and translate environmental knowledge into action.

To address this limitation, some recent studies have begun to shift the focus from "the intention to become an entrepreneur" to "the capability to become a green entrepreneur." García Hernández *et al*. (2025) found that green skills (GS) are conceptualized as including "green knowledge" (GKN), "mastery of green skills" (MGS), "use of green skills" (UGS), and "green skill development" (GSD). Within environmental education, these dimensions reflect students' capacity to understand environmental problems, evaluate sustainable practices, and apply green knowledge to ecological and resource-related challenges. Nevertheless, research on GS has mainly focused on its direct relationship with intention, leaving unclear how such competencies become actionable responses.

A relevant mechanism is green opportunity recognition (GOR). According to Lwin *et al*. (2026), GOR reflects an individual's ability to identify and evaluate business opportunities arising from environmental problems. In environmental education, it captures whether students can convert such problems into feasible sustainability-oriented responses. Thus, GS becomes an entrepreneurial driver when students recognize environmental

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problems as concrete and feasible business opportunities (Rafiq *et al*., 2024; Lwin *et al*., 2026). However, GOR has not been sufficiently connected with GS and GenAI.

The rapid development of GenAI has opened a new research direction in entrepreneurship education (EE) and GE. Nevertheless, existing studies have not clarified whether generative AI adoption (GAA) can support the development of GS and GOR. In higher education, GenAI may support environmental information search, comparison of sustainable alternatives, and green solution development. Yet technology use alone is not environmental learning; its relevance depends on transforming information into green competencies and feasible responses. Therefore, GenAI should be examined as support for environmental education rather than merely as a digital entrepreneurship tool.

Beyond technology, the transformation of GS and GOR into GEI may depend on the educational environment. In the Vietnamese context, Pham *et al*. (2026) showed that SEE can strengthen the relationship between GOR and SEI. Based on these gaps, this study integrates human capital theory (HCT), opportunity recognition theory (ORT), and person–environment fit theory (PEFT) to explain how GAA relates to GEI through GS and GOR, with SEE as a boundary condition. By doing so, the study positions GEI as an education-based response to environmental challenges rather than merely as a business intention. It identifies a capability-to-action pathway from AI-supported learning to green competencies, environmental problem interpretation, and intended action. Hence, this study has three research questions.

RQ1. How is GAA associated with students' GS and GOR in the context of environmental education?

RQ2. How do GS and GOR explain the relationship between GAA and GEI as a sustainability-oriented response to environmental problems?

RQ3. How does SEE moderate the relationships between GS and GOR, and between GOR and GEI?

Literature review

Theoretical background

Human capital theory (HCT)

The theory views education, training, knowledge, and skills as investments that can enhance productivity, decision-making capacity, and future economic outcomes (Becker, 1989; Schultz, 1961). In entrepreneurship research, it explains how education, experience, and specialized capabilities increase individuals' ability to recognize opportunities and create ventures (AlQershi *et al*., 2023). This lens is relevant to GE because environmentally oriented ventures require entrepreneurial motivation and capabilities for understanding environmental problems and developing sustainable responses (Prabowo *et al*., 2022; Huang *et al*., 2026). In the present study, HCT positions GS as the capability mechanism linking environmental learning with GEI and GAA as a technology-enabled resource for developing green human capital.

Opportunity recognition theory (ORT)

ORT is rooted in Kirzner's (1973) notion of entrepreneurial alertness and was later developed by Shane and Venkataraman (2000), who conceptualized entrepreneurship as discovering, evaluating, and exploiting opportunities. This theory is highly relevant to GE because environmental problems do not automatically become business opportunities. Individuals must interpret pollution, resource waste, energy inefficiency, green consumption, or circular economy practices as situations requiring sustainable and feasible solutions (Chapman & Hottenrott, 2022; Rafiq *et al*., 2024). In the present study, ORT positions GOR as the cognitive mechanism translating environmental knowledge into sustainability-oriented opportunities.

Person–environment fit theory (PEFT)

The core mechanism of this theory is that individual attitudes, behaviors, and outcomes depend on compatibility between personal characteristics and environmental conditions (Caplan, 1987; Edwards, 2008; Kristof, 1996). This theory is relevant to GE because students' GS and opportunity recognition may not lead to entrepreneurial intention without an educational environment supporting sustainability-oriented action (Fichter & Tiemann, 2018; Forliano *et al*., 2021; Qazi *et al*., 2021). In Vietnam, Pham *et al*. (2026) applied PEFT and showed that SEE strengthens the relationship between SOR and SEI. In the present study, PEFT positions SEE as a moderator of the capability–intention link.

Hypotheses development

Generative AI adoption (GAA) and green skills (GS)

GAA refers to the extent to which individuals use GenAI tools, such as ChatGPT, Gemini, Copilot, or DeepSeek, to support learning, information search, content generation, problem analysis, and idea development. In educational contexts, GenAI can help students access knowledge, process complex information, and develop problem-solving capabilities (Ahmad, 2025). Meanwhile, GS refers to knowledge and capabilities enabling individuals to understand, use, and develop competencies in environmental protection, resource efficiency, and sustainability (García Hernández *et al*., 2025). In this study, GenAI supports GS by providing environmental information, explaining sustainability concepts, and helping students explore responses to ecological and resource-related problems. Hence, we suggest a hypothesis:

H1: GAA positively influences GS.

Generative AI adoption and green opportunity recognition (GOR)

Selvan *et al*. (2026) defined GOR as the ability to identify and assess GBO arising from environmental issues in the surrounding context. GOR reflects students' capacity to interpret pollution, waste, resource inefficiency, and sustainability needs as opportunities for feasible solutions. GenAI can support this process by helping students search for information, analyze green consumption trends, compare sustainable business models, identify local environmental problems, and generate green venture ideas. Hence, we suggest a hypothesis:

H2: GAA positively influences GOR.

Green skills and green entrepreneurial intention (GEI)

GEI refers to an individual's willingness and determination to start or pursue a business that creates environmental value alongside economic value. Hence, GS may strengthen GEI by providing students with the knowledge and confidence to view GE as a feasible response to sustainability challenges. García Hernández *et al*. (2025) found that GS are positively associated with students' GEI. Hence, we suggest a hypothesis:
H3: GS positively influences GEI.

Green skills and green opportunity recognition

Although GS can directly support GEI, its entrepreneurial value depends on opportunity recognition. Green knowledge becomes actionable when students interpret environmental problems as situations in which feasible, sustainability-oriented solutions can be developed (García Hernández *et al*., 2025; Huang *et al*., 2026). In the context of GE, Lwin *et al.* (2026) found that GOR plays an important role in shaping GEI. Therefore, students with stronger GS should better understand environmental problems, evaluate green solutions, and recognize unmet sustainability-related needs. Hence, we suggest a hypothesis:
H4: GS positively influences GOR.

Green opportunity recognition and green entrepreneurial intention

GOR is a crucial step in translating environmental awareness into GEI. In GE, opportunities arise not only from market gaps but also from pollution, waste, resource inefficiency, and other environmental problems requiring innovative, market-based solutions (Lwin *et al*., 2026; Selvan *et al*., 2026). In the context of GE, Lwin *et al*. (2026) found that GOR has a positive and significant effect on GEI. Similarly, Pham *et al*. (2026) confirmed the importance of SOR in explaining students' SEI in Vietnam. Hence, we suggest a hypothesis:
H5: GOR positively influences GEI.

Mediating roles of green skills

Extending this logic from a capability perspective, this study argues that GenAI helps students access environmental knowledge, analyze sustainability challenges, and develop GS. These capabilities connect AI-supported learning with environmental problem-solving and green intention. They are important because GS and green knowledge capabilities can strengthen green innovation and GEI (García Hernández *et al*., 2025; Huang *et al*., 2026). Hence, we suggest a hypothesis:
H6: GS mediates the relationship between GAA and GEI.

Mediating roles of green opportunity recognition

GS equips students to understand environmental problems. However, intention is more likely when these capabilities become recognizable opportunities for addressing such problems. This logic is consistent with ORT, which views opportunity recognition as a cognitive mechanism connecting prior knowledge and information with entrepreneurial action. In GE, Lwin *et al*. (2026) found that GOR mediates the relationship between individual characteristics and GEI. Besides, GenAI can help students analyze green market trends, explore environmental problems, compare sustainable business models, and simulate green venture ideas. However, GenAI is unlikely to affect GEI solely through technology use. Its effect is more likely to operate through students' ability to identify feasible GBO addressing environmental needs. Hence, we suggest hypotheses:
H7a: GOR mediates the relationship between GS and GEI.
H7b: GOR mediates the relationship between GAA and GEI.

Moderating role of sustainable entrepreneurship education (SEE)

SEE refers to educational activities that help students develop the knowledge, skills, and motivation needed to pursue entrepreneurship integrating economic, social, and environmental goals (Makuya & Changalima, 2024; Mambali *et al*., 2024; Chahal *et al*., 2025). Recent studies further show that EE is more effective when it combines theoretical knowledge, practical projects, exposure to green entrepreneurs, and university-based support (Adjimah *et al*., 2026; Chatterjee *et al*., 2026; Saleh *et al*., 2026). Such support helps students apply GS when identifying environmental opportunities. Therefore, when SEE is high, students are more likely to use GS to identify and evaluate GBO.
Besides, although students may recognize GBO, they may still lack knowledge about market evaluation, business model design, and resource mobilization. In this regard, SEE can reduce uncertainty and make recognized environmental opportunities more actionable (Al-Sunbul *et al*., 2024; Kochkonbaevich *et al*., 2024; Prada *et al*., 2024; Yen *et al*., 2024; Cavero & Ferraz, 2025; Magomedova *et al*., 2025; van Dijk *et al*., 2025; Alhamaimi *et al*., 2026; Alharbi & Algarni, 2026; Ghi & Trung, 2026; Tabaldyev *et al*., 2026). Pham *et al.* (2026) found that SEE strengthens the relationship between SOR and SEI. Hence, we suggest hypotheses:
H8a: SEE moderates the relationship between GS and GOR.
H8b: SEE moderates the relationship between GOR and GEI.
Figure 1 presents the proposed research model and the hypothesized relationships among the study constructs.

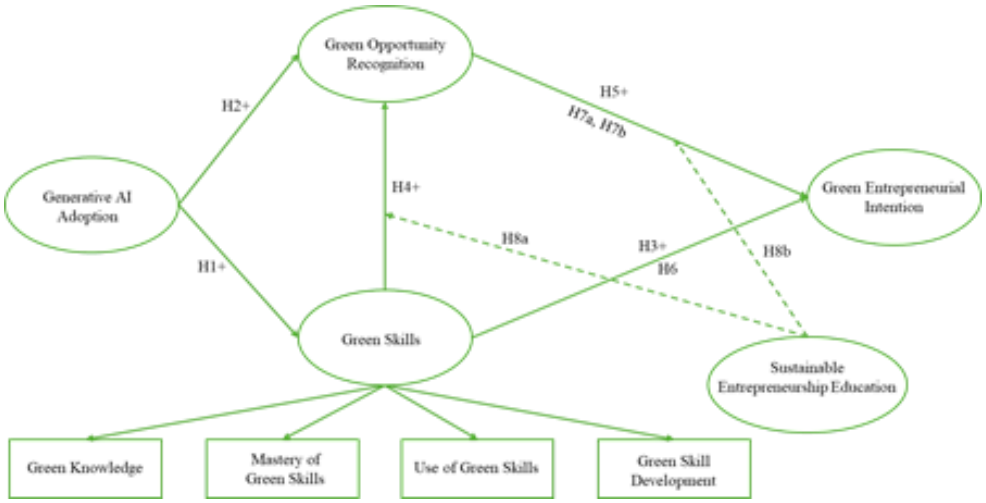

Figure 1. Research model

MATERIALS AND METHODS

Research context

Vietnam is undergoing a simultaneous transition toward green growth, digital transformation, and innovation-driven entrepreneurship. At the policy level, Vietnam has approved the National Green Growth Strategy for 2021–2030 (Government News, 2021). Vietnam has also committed to achieving net-zero emissions by 2050 and is advancing energy transition, carbon-market development (Reuters, 2025; Government News, 2026). These transitions create a growing demand for young people who possess green knowledge, green skills, and the ability to identify sustainability-oriented business opportunities. They also highlight the importance of environmental education in preparing students to understand environmental degradation, resource inefficiency, pollution-related problems, and sustainable development challenges. At the same time, Vietnam is rapidly integrating digital technologies and artificial intelligence into education and innovation ecosystems. Therefore, Vietnam offers a suitable setting to examine how GAA is associated with students' green skills, green opportunity recognition, and green entrepreneurial intention within broader efforts to promote sustainability-oriented environmental learning and action.

Measurement scales

The questionnaire was developed based on established measurement scales from prior studies and was adapted to fit the context of university students in Vietnam. Specifically, GAA and GEI from Kong *et al*. (2025). GS were conceptualized as including GKN, MGS, UGS, and GSD, following García Hernández *et al*. (2025). GOR from Zixin *et al*. (2026). SEE from Chahal *et al*. (2025). First, the original English items were translated into Vietnamese and contextually modified. Second, the questionnaire was reviewed by experts, including lecturers and researchers with expertise in entrepreneurship and sustainability. Third, a pilot test was conducted with a small group of students. All measurement items were assessed using a five-point Likert scale, ranging from 1 = "strongly disagree" to 5 = "strongly agree." The final questionnaire included screening questions, basic demographic information, and the adapted measurement items.

Data collection

This study employed a purposive sample. This approach is suitable because the target population consists of university students who have used GenAI, and obtaining a complete sampling frame for this group is difficult.

For the online survey, the questionnaire was designed using Google Forms and distributed through student learning groups, social media platforms, student clubs, and university student communities. For the face-to-face survey, QR codes linked to the online questionnaire were used.

Before completing the questionnaire, participants were informed about the research purpose, the voluntary nature of participation, and the confidentiality of their responses. Responses were excluded if they failed to meet the screening criteria, contained substantial missing data, showed straight-lining patterns, or were completed in an unrealistically short time.

Sample size

The sample size was determined based on the number of observed variables and the requirements of structural equation modeling. The research model includes 35 observed indicators measuring GAA, GS, GOR, SEE, and GEI. Following a commonly used rule of thumb in structural equation modeling, the minimum sample size per indicator should range from 5 to 10 observations (Hair *et al*., 2021). Based on 35 observed indicators, the minimum required sample size ranges from 175 to 350 valid responses. In this study, the authors collected 616 responses. After filtering out invalid responses, the final dataset contained 599 valid responses. This sample size exceeds the recommended minimum threshold. The sample profile is presented in **Table 1.**

Table 1. Demographic characteristics

Variable	Category	Frequency	Percentage
Total		599	100.0
Gender	Male	291	48.6
	Female	308	51.4
Academic year	First year	56	9.3
	Second year	125	20.9

	Third year	220	36.7
	Fourth year or above	198	33.1
Field of study	Business/Economics	318	53.1
	Engineering/Technology	180	30.1
	Social sciences	101	16.9
Experience using GenAI	Less than 3 months	76	12.7
	3–6 months	155	25.9
	7–12 months	205	34.2
	More than 12 months	163	27.2
Frequency of GenAI use	Rarely	42	7.0
	Sometimes	194	32.4
	Often	241	40.2
	Very often	122	20.4

Data analysis

After data collection, the responses were screened, coded, and analyzed using SPSS 27.0 and SmartPLS 4.1. PLS-SEM was selected for two reasons. First, the proposed model is relatively complex, as it includes multiple latent variables, a second-order construct, and both mediation and moderation effects. Second, survey data based on Likert-scale items may not fully satisfy the assumption of multivariate normality, whereas PLS-SEM is less restrictive regarding data distribution assumptions (Hair *et al*., 2019).

RESULTS AND DISCUSSION

Measurement model

Table 2. First-order measurement model

Construct	Items	Outer loading	Cronbach's alpha	Composite reliability (rho_c)	AVE
GAA	5	0.838–0.863	0.904	0.928	0.722
GKN	4	0.852–0.874	0.884	0.920	0.741
MGS	4	0.766–0.802	0.798	0.869	0.623
UGS	4	0.788–0.809	0.813	0.877	0.640
GSD	3	0.870–0.894	0.853	0.911	0.773
GOR	5	0.836–0.853	0.896	0.923	0.707
GEI	5	0.841–0.866	0.904	0.929	0.723
SEE	5	0.821–0.868	0.895	0.922	0.704

Table 2 showed that all first-order constructs had outer loading ranges above the commonly recommended threshold of 0.70. Cronbach's alpha values ranged from 0.798 to 0.904, exceeding the minimum threshold of 0.70. In addition, all AVE values were above 0.50, ranging from 0.623 to 0.773. Thus, convergent validity was established (Hair *et al*., 2021).

Table 3. Second-order construct assessment

Construct	Items	Outer loading	Cronbach's alpha	Composite reliability (rho_c)	AVE
GAA	5	0.838–0.863	0.904	0.928	0.722
GS	4	0.877-0.907	0.913	0.939	0.793
GOR	5	0.836–0.853	0.896	0.923	0.707
GEI	5	0.841–0.866	0.904	0.929	0.723
SEE	5	0.821–0.868	0.895	0.922	0.704

Table 3 shows that GS has strong measurement properties (Hair *et al*., 2022).

Table 4. HTMT value

	GAA	GEI	GOR	GS	SEE	SEE x GOR	SEE x GS
GAA							
GEI	0.517						
GOR	0.703	0.721					
GS	0.666	0.666	0.720				
SEE	0.185	0.107	0.133	0.260			
SEE x GOR	0.061	0.251	0.130	0.105	0.023		
SEE x GS	0.033	0.084	0.107	0.105	0.066	0.607	

In **Table 4**, all HTMT values are below the conservative threshold of 0.85, indicating that the constructs are empirically distinct (Henseler *et al*., 2015).

The Fornell–Larcker criterion was also satisfied, as the square roots of AVE were higher than the inter-construct correlations (Fornell & Larcker, 1981).

Common method bias (CMB)

First, procedural controls were incorporated into the questionnaire design (Podsakoff *et al*., 2003). The items were written clearly and concisely, and the measurement items for different constructs were arranged in separate sections. Second, Harman's single-factor test was conducted. The results showed that the first unrotated factor accounted for 40.134% of the total variance, which is below the threshold of 50% (Cooper *et al*., 2020). Third, full collinearity was assessed using the variance inflation factor (VIF) values. All VIF values are below the recommended threshold of 3.3.

Structural equation modelling

Table 5. The path coefficient

Hypothesis	Path	β	STDEV	t-value	95% CI	p-value	f^2	VIF	Decision
Direct impact									
H1	GAA => GS	0.606	0.027	22.200	[0.551,0.658]	0.000	0.579	1.000	Supported
H2	GAA => GOR	0.367	0.034	10.665	[0.301,0.435]	0.000	0.184	1.585	Supported
H3	GS => GEI	0.320	0.038	8.382	[0.244,0.393]	0.000	0.114	1.818	Supported
H4	GS => GOR	0.453	0.037	12.280	[0.380,0.523]	0.000	0.270	1.646	Supported
H5	GOR => GEI	0.426	0.039	10.835	[0.348,0.502]	0.000	0.210	1.751	Supported
Moderator impact									
H8a	SEE × GS => GOR	0.148	0.029	5.091	[0.090,0.204]	0.000	0.049	1.015	Supported
H8b	SEE × GOR => GEI	0.150	0.027	5.493	[0.092,0.198]	0.000	0.047	1.016	Supported
Indirect impact									
H6	GAA=>GS=>GEI	0.194	0.025	7.703	[0.146,0.245]	0.000			Supported
H7a	GS=>GOR=>GEI	0.193	0.023	8.343	[0.150,0.241]	0.000			Supported
H7b	GAA=>GOR=>GEI	0.157	0.022	7.220	[0.116,0.201]	0.000			Supported

For the direct effects, GAA positively affects GS (β = 0.606), supporting H1. GAA also positively affects GOR (β = 0.367), supporting H2.

GS positively affect GEI (β = 0.320) and GOR (β = 0.453), supporting H3 and H4. In addition, GOR positively influences GEI (β = 0.426), supporting H5. Regarding moderation, SEE significantly moderates the GS–GOR relationship (β = 0.148) and the GOR–GEI relationship (β = 0.150), supporting H8a and H8b. For the indirect effects, GS significantly mediates the relationship between GAA and GEI (β = 0.194), supporting H6. GOR also significantly mediates the relationship between GS and GEI (β = 0.193), supporting H7a. In addition, GOR significantly mediates the relationship between GAA and GEI (β = 0.157), supporting H7b. The effect size results indicate that GAA => GS has a large effect, GAA => GOR, GS => GOR, and GOR => GEI have moderate effects, and the remaining effects are small to moderate. All VIF values range from 1.000 to 1.818, indicating that multicollinearity is not a concern **(Table 5)**.

Table 6. Adjusted R^2

Construct	R^2	Adjusted R^2
Green Skills (GS)	0.367	0.366
Green Opportunity Recognition (GOR)	0.538	0.535
Green Entrepreneurial Intention (GEI)	0.505	0.502

The results in **Table 6** indicate that the model has adequate explanatory power. GAA explains 36.6% of the variance in GS. The model explains 53.5% of the variance in GOR and 50.2% of the variance in GEI.

This study examined the relationships between GAA and GEI through GS and GOR, while considering the moderating role of SEE. The findings support a capability-to-action explanation of GenAI in environmental education: technology adoption is associated with GEI when AI-supported learning develops green capabilities and helps students interpret environmental problems as sustainability-oriented opportunities.

H1 was supported, showing that GAA is positively associated with GS. The finding is consistent with Kong *et al*. (2025), who argued that GenAI can reshape students' learning, thinking, and sustainable entrepreneurial cognition. This study extends these findings by indicating that GenAI is related to green-specific human capital, including students' ability to understand environmental issues, analyze green information, and apply sustainability-related knowledge. Thus, the environmental relevance of GenAI lies in competence development rather than technology use alone.

H2 was supported, indicating that GAA is positively associated with GOR. This finding is consistent with Selvan *et al*. (2026), who reported that AI adoption contributes to green innovation and GEI. The result indicates that AI-supported learning can help students interpret environmental degradation and resource inefficiency as sources of sustainability-oriented solutions.

H3 was supported, showing that GS are positively associated with GEI. This result is consistent with García Hernández *et al*. (2025), who found that GS are positively associated with students' GEI. This suggests that GEI depends on students' capacity to apply green knowledge to environmental protection, sustainable resource use, and ecological problem-solving.

H4 was supported, indicating that GS are positively associated with GOR. This finding supports ORT, which argues that prior knowledge and cognitive alertness help individuals identify opportunities (Kirzner, 1973; Shane & Venkataraman, 2000). The result indicates that stronger GS help students interpret environmental problems and evaluate feasible sustainability-oriented solutions.

H5 was supported, showing that GOR is positively associated with GEI. This finding is consistent with Lwin *et al*. (2026), who found that GOR significantly strengthens GEI. From an environmental perspective, students are more likely to pursue green ventures when they can connect environmental problems with feasible responses involving pollution reduction, resource efficiency, or sustainable consumption.

H6 was supported, confirming that GS mediate the relationship between GAA and GEI. This result identifies green competence as a pathway through which AI-supported learning is associated with entrepreneurial intention. GenAI should therefore be regarded as a learning resource whose environmental value depends on students' ability to acquire and apply GS.

H7a was supported, showing that GOR mediates the relationship between GS and GEI. This result is consistent with Lwin *et al*. (2026), who found that GOR mediates the relationship between individual characteristics and GEI. This suggests that green capabilities become more relevant to intention when students transform them into feasible GBO addressing environmental needs.

H7b was supported, indicating that GOR mediates the relationship between GAA and GEI. The finding is consistent with studies showing that AI adoption can support green innovation and GEI (Selvan *et al*., 2026). Thus, GOR links AI-supported learning with GEI by converting environmental information into recognizable sustainability-oriented opportunities (Ahmad *et al*., 2024; Berger *et al*., 2024; El-Kholy *et al*., 2024; Ghati *et al*., 2024; Kim *et al*., 2024a; Kim *et al*., 2024b; Mei *et al*., 2024; Owusu *et al*., 2024; Ricci *et al*., 2025; Sørensen & Holst, 2025; Torres & Fernandez, 2025).

H8a was supported, showing that SEE positively moderates the relationship between GS and GOR. The result is consistent with Adjimah *et al*. (2026), who showed that entrepreneurship education components, such as theoretical knowledge, practical projects, and exposure to green entrepreneurs, can shape GEI. SEE strengthens the conversion of GS into GOR by providing environmental knowledge, sustainability examples, and activities for evaluating green solutions.

H8b was supported, indicating that SEE moderates the relationship between GOR and GEI. This result is consistent with Pham *et al*. (2026), who found that SEE strengthens the relationship between SOR and SEI in Vietnam. Thus, SEE helps students evaluate opportunities and translate them into intentions to address environmental degradation through sustainability-oriented initiatives.

CONCLUSION

Theoretical contributions

This study makes several theoretical contributions to environmental education, sustainability, and green entrepreneurship literature. First, it extends prior research on GEI by introducing GAA as a technology-enabled antecedent. While previous studies have mainly emphasized psychological, educational, and contextual factors in explaining GEI or SEI (Adjimah *et al*., 2025; Talukder *et al*., 2025; Valencia-Arias *et al*., 2025), this study distinguishes GenAI adoption from environmental learning outcomes. It shows that GAA is relevant through its relationships with green competence, environmental problem interpretation, and sustainability-oriented intention.

Second, this study advances HCT by positioning GS as a specialized form of green human capital. Prior research has shown that GS are associated with GEI (García Hernández *et al*., 2025), while green knowledge capabilities support green innovation and GEI (Huang *et al*., 2026). This study extends these findings by identifying GS as the capability pathway connecting AI-supported learning with GEI through environmental understanding, sustainable resource use, and green problem-solving.

Third, this study contributes to ORT by identifying GOR as a key cognitive mechanism linking GAA, GS, and GEI. Previous research has confirmed the importance of GOR or SOR in forming GEI or SEI (Lwin *et al*., 2026; Pham *et al*., 2026). This study extends this stream by showing that GOR explains how AI-supported information and GS become relevant to GEI when students recognize environmental problems as feasible sustainability-oriented opportunities.

Fourth, this study enriches PEFT by demonstrating the boundary role of SEE. Prior studies have emphasized the importance of entrepreneurship education and university support in shaping green entrepreneurial mindsets and outcomes (Adjimah *et al*., 2026; Chatterjee *et al*., 2026; Saleh *et al*., 2026). This study adds that SEE strengthens both the GS–GOR and GOR–GEI relationships. Overall, the model connects digital learning, green capabilities, opportunity recognition, and intended sustainability-oriented action.

Practical contributions

The findings offer several practical implications. First, because GAA is strongly associated with GS, universities should embed tools such as ChatGPT, Gemini, Copilot, or DeepSeek in environmental learning tasks, including identifying pollution-related problems, analyzing resource use, comparing green solutions, and developing environmentally responsible ideas. Students should also verify AI-generated information and assess the environmental assumptions underlying proposed solutions. Second, since GS is significantly associated with both GOR and GEI, universities should strengthen green knowledge and practical GC through environmental education, sustainability projects, and problem-based activities related to waste reduction, resource efficiency, and environmental protection. Third, entrepreneurship programs should help students identify GBO in Vietnam, evaluate their environmental and commercial feasibility, and distinguish genuine environmental value from superficial green claims. Fourth, because SEE strengthens the effects of GS and GOR, courses should connect sustainability knowledge with opportunity evaluation and implementation.

Limitations and future research directions

This study has several limitations. First, its cross-sectional design limits causal inference. Future studies should use longitudinal or experimental designs to examine how GAA, GS, GOR, and GEI develop over time. Second, this study focuses on GEI rather than actual green entrepreneurial behavior; therefore, future research should examine whether these intentions lead to implemented environmental initiatives. Third, this study only considers GS and GOR as mediators and SEE as the moderator. Future studies could examine green entrepreneurial self-efficacy, entrepreneurial alertness, AI literacy, university support, and access to green finance. Finally, future research should consider potential negative effects of GenAI, such as AI dependency, information overload, privacy concerns, inaccurate environmental information, and reduced critical thinking. Future studies could also examine direct outcomes, such as participation in waste reduction, biodiversity conservation, sustainable resource management, or environmental protection projects.

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