Reflection on Environmental Sustainability Practices in University General Education Courses and Exploration of STEAM-6E Development Education

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ABSTRACT:

The sustainable vision based on low-carbon communities has illuminated the dream of rural estates in Taiwan's cities, and this beautiful blueprint has been implemented in May-uan Village, Douliu City. The themes of "environmental sustainability" and "community practice" are integrated into the university's general education curriculum. Qualitative research methods are used to collect data through literature analysis, observation, interviews, and teaching case data analysis. Through the cooperation and leadership of local volunteers and the emotional connection with students during service, we guide students to reflect on themselves, solve problems together as a team, and explore why environmental education requires holistic thinking and action. Secondly, the relevance of STEAM-6E development education and college students' participation in sustainable action is discussed. Finally, environmental education design suggestions from the perspective of college students are proposed to respond to the needs of many general education teachers to advocate environmental sustainability education and social and cultural environmental education in the future.

1. Introduction

Focusing on the general education course "Environmental Ethics and Sustainable Development" at a normal university, this study explores students' knowledge, attitudes, and actions toward sustainable development. According to Zhuang (2005), most university students' understanding of sustainable development remains at the stage of "having heard of it but not clearly understanding" or merely "having read about it." This indicates a gap in the implementation of sustainability education in Taiwanese classrooms. Although the government has promoted Education for Sustainable Development (ESD) policies and provided subsidies for related curriculum development, practical implementation in classrooms remains insufficient. For example: Many schools set many KPIs (Key Performance Indicators) and hold many lively activities to encourage everyone to participate, but ignore how to deeply embed them into classroom teaching (Wu, 2025; Yang, & Kao, 2019), resulting in a "policy without practice" issue. In response to UNESCO's advocacy of holistic Education for All (EFA), Climate Change Education (CCE), and Education for Sustainable Development (ESD) (Yeh, 2017), this study adopts

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a teaching practice perspective to develop a curriculum design that can be deeply integrated into campuses and students' learning experiences.

The curriculum integrates the STEAM-6E instructional model, emphasizing real-world contexts, hands-on learning, interdisciplinary collaboration, and design thinking to cultivate students' problem-solving and integrative application skills (Chanung et al., 2022; Luo, 2023; Zhang, 2018; Hunter-Doniger & Sydow, 2016). During the first eight weeks, the course is conducted through lectures and discussions; in the following eight weeks, students participate in volunteer service at the Tzu-Xin Organic Farm, where they develop personal growth, teamwork, and a sense of social responsibility. By engaging in plant-based diet promotion and environmental actions, students strengthen their awareness of environmental protection.

Weekly reflective writing assignments help students internalize what they have learned and transfer it into everyday practice, enhancing their psychological resilience and empathy while deepening their critical thinking and engagement with social issues (Yang et al., 2021). This study emphasizes the importance of cultivating sustainable citizens with critical thinking and systems integration literacy, thereby advancing the implementation of ESD in general education at the university level (Chiang, 2025).

2. Methods

This study follows the recommendations of Johnson, R., & Waterfield, J (2004) by employing purposive sampling and snowball sampling methods. The selection of research participants was based on theoretical relevance, as well as the richness and completeness of the data. Therefore, eight top-performing students in the class were selected as interviewees. This study attempts to use outstanding students as models, hoping to awaken other students' imitation and learning. With an average age of 20.1 ± 1. The course was conducted from September 2024 to January 2025. Basic demographic information—including gender, department, age, and semester grades—was used to support and contextualize the interview data (Table 1).

Table 1. Basic Information of Interviewees

No.	Department	Year Level	Gender	Age	Semester Grade
A	Department of Digital Media	Freshman	F	19	99
B	Department of Digital Media	Freshman	F	19	99
C	Department of Electrical Engineering	Junior	M	21	96
D	Department of Chemical and Materials Engineering	Sophomore	M	20	98
E	Department of Electrical Engineering	Junior	M	21	94
F	Department of Industrial Management	Freshman	F	19	97
G	Department of Electrical Engineering	Junior	M	21	95
H	Department of Electrical Engineering	Junior	M	21	96

In this study, data were coded using distinct identifiers. The eight participants were labeled A–H in alphabetical order. Two types of data were collected: (1) weekly

learning reflections, e.g., "Reflection A1," and (2) interview transcripts, e.g., "Interview A1," indicating excerpts from participant A. To uphold research ethics, any data involving personal privacy were included or omitted based on participants' consent.

Both the researcher and assistants held positions at the assistant professor level or above, each with over ten years of experience teaching general education. After reviewing the reflections and drafting the interview guide, the researcher consulted three senior psychology faculty members. After reaching consensus throughout the reflective data review, data analysis used transcript review, open coding, axial coding, and selective coding. Thematic analysis of the interview transcripts was also conducted using the STEAM-6E framework (engage, explore, interpret, design, enrich, and evaluate).

2.1 Reflective Learning Analysis

Following grounded theory (Strauss & Corbin, 1990), students' reflections were conceptualized and categorized. The number of coded items per participant were: A (14), B (19), C (8), D (19), E (7), F (6), G (6), and H (6). A classification table was compiled, followed by the identification of a core category and the systematic verification of relationships across categories. Irrelevant items were removed, as shown in Table 2. Missing elements were supplemented, and refined selective coding factors were finalized.

Table 2: Analysis Table of Deleted Open Coding Items in Students' Reflections

Selective Coding	Axial Coding	Open Coding	Remarks
Body	Physical Experience	"Carrying things by shoulder was efficient, but insects crawled on me, so I'll be more careful next time." (Reflection H80)	Deleted
		"At first, I helped senior volunteers move tables. After stacking them, we had to push the shelf onto the truck." (Reflection H85)	Deleted
	Learned Skills	"Luckily, I knew how to scrub the fridge back to white, but I couldn't reach the narrow gaps." (Reflection B16)	Deleted
		"According to the seniors, the purpose was to organize the area for building or displaying items." (Reflection D58)	Deleted

2.2 Environmental Sustainability Interview

This study referenced Luo's (2023) STEAM-6E instructional model to design a learner-centered curriculum that emphasizes real-world contexts and core design concepts. Based on this framework, a semi-structured in-depth interview guide was developed to explore students' environmental sustainability practices in a general education course at the university level. All interviews were conducted personally by the researcher, with full disclosure of the study's purpose, procedures, and participants' rights. Interviewees were informed that the sessions would be audio-recorded. The total interview duration amounted to 595 minutes.

For data analysis, this study adopted Braun and Clarke's (2006) thematic analysis approach. The process involved first identifying themes, then defining the meaning of patterns, followed by anchoring themes in the data by identifying commonalities in the students' verbatim transcripts. The final step involved presenting the overall structure and supporting content. After analyzing the initial set of interview questions, items with

insufficient supporting data for thematic classification were removed, as shown in Table 3.

Table 3. Factors Removed from Thematic Analysis of Student Interviews

Theme Category	Common Description	Representative Student	Remarks
Sustainability as a Global and Future Trend	Emphasizes that sustainability aligns with global development and future workplace demands.	Interview F3-4: "In the future, many companies will adopt this strategy to demonstrate their international orientation…" Interview D2-3: "If everyone holds destructive views toward the environment... resources will become increasingly scarce."	Deleted
Value of Diverse and Interdisciplinary Learning	Acknowledges the potential of sustainability courses to integrate various disciplines and learning modes.	Interview F7-8: "Environmental sustainability itself is an interdisciplinary subject… it helps us develop multiple perspectives and thinking approaches."	Deleted

3. Results and Discussion

The results from the 8-week service reflections were compiled through selective coding, axial coding, and open coding. Among them, the axial codes related to specific sequences and frequency of participation included the following five open codes:

"Movements involving the limbs and grounding are really good for the body." (Reflection A11). "Digging up stone slabs takes a lot of effort, but it's also great for building strength—pretty good!" (Reflection C34). "I kept losing balance when pushing the wheelbarrow. It really felt like nature's gym, but after a few tries, it got smoother." (Reflection E61). "Throwing large stones made my muscles sore. By switching places with teammates often, we trained different muscle groups." (Reflection G77). "In terms of physical training, this activity was really suitable—I enjoyed this experience." (Reflection H81).

The axial codes "fitness experience," "acquiring new skills," and "community engagement" were grouped under the selective code Body. The axial codes "sense of achievement," "sense of fulfillment," "fun atmosphere," and "team collaboration" were categorized under the selective code Mind. Lastly, the axial codes "cherishing the Earth," "life education," "self-growth," "awareness and gratitude," and "aesthetic appreciation" were grouped under the selective code Spirit, as shown in Table 4. The course of this study is designed with reflective writing, discussion and review mechanisms to allow students to integrate their feelings and connect with their life experiences, which will help transform experience into long-term belief changes (Mezirow, 1997).

Table 4. Summary of Selective, Axial, and Open Coding in 8-Week Reflection Factors

Selective Coding	Axial Coding	Open Coding
Body	Fitness Experience	A11, C34, E61, G77, H81
	Acquiring New Skills	A2, B15, B18, B19, E62, F69, F70, F71
	Practicing in Community	B22, B32, C39, C41, D44

Selective Coding	Axial Coding	Open Coding
Mind	Sense of Achievement	A1, B13, B21, B28, D45, D52, E64
	Feeling Fulfilled	68, A7, A12, H80, H84
	Fun and Atmosphere	A3, B18, B23, C36, C37, C38, 74
	Teamwork	B20, B24, B30, D43, E63, H85
Spirit	Cherishing the Earth	A4, A14, B9, B19, D46, D47, G75, G76, G78
	Life Education	A5, A6, A8, D56, F73
	Personal Growth	A10, C35, C40, D42, D58, D59, D60, E65
	Awakening and Gratitude	B17, B25, B33, E66, H82
	Aesthetic Appreciation	D55, D57, E67, G79, H83

This table omits the English words in each student's representative, and should be marked with (reflection)

Many studies have indicated that through experiential learning—such as community service or outdoor activities—students can acquire new skills through hands-on practice, which in turn enhances their self-efficacy and sense of fulfillment. Personal or behavioral change can also occur outside formal school settings, suggesting that learning is not limited to instruction by school teachers (Wu et al., 2024). When students participate in practical activities at the Grand Manor Farm, they not only strengthen their physical participation and learn new skills, but also further practice community action and cooperation with neighbors, which corresponds to the "Body" dimension. In the "Mind" dimension, participation in environmental and community-related activities fosters a psychological flow state, a sense of accomplishment and satisfaction, and helps create an atmosphere of enjoyment and teamwork. This aligns with findings on the sustained motivation of ecological and conservation volunteers, who experience joy from both the activities and the people they encounter, and find meaningful value and a sense of fulfillment in their connection with nature through volunteer service (Ganzevoort & Riyan, 2023).In the "Spirit" dimension, there is a significant positive correlation between contact with nature, connectedness to the natural world, and mental health, which is strongly influenced by spirituality. Research has concluded that spirituality can shape how people experience the importance of natural activities and generate positive effects as a result (Kamitsis & Francis, 2013). At the end of university service-learning courses, students who participated in service showed greater improvements in personal, community, environmental, and spiritual well-being than those who did not. They also experienced significant reductions in stress, anxiety, and depressive emotions (Pong, 2022).

Traditional general education often emphasizes knowledge transmission, making it difficult to promote deep internalization and practical motivation among students (Jickling & Sterling, 2017). In contrast, experiential and practice-oriented courses can enhance students' awareness, emotional connection, and willingness to act on environmental issues through direct participation and local engagement (Kolb, 2015).

This course emphasizes the interweaving of "physical practice" and "emotional response", and further guides students to reflect on "spiritual values". Such teaching arrangements are relatively rare in Asian general education. Compared with service learning courses that generally focus only on skill practice or social care, this course attempts to touch the existential level of learners. Through the process of actual

participation in labor, physical involvement and interaction with others, it guides students to re-understand their roles and meanings in the group, society and even the natural environment. Such a course design not only responds to the basic spirit of experiential learning, but also expands the possibility of general education focusing on the development of the whole person.

Therefore, this study aims to explore how integrating "environmental sustainability practices" into general education curriculum influences students' learning processes and sustainability consciousness. This issue was included as the first item in the interview outline. Through thematic analysis, three major themes emerged: "Practical experiences promote understanding and empathy," "Environmental sustainability must begin with student education," and "Integrating environmental sustainability into general education is valuable." Each student's narrative is presented in Table 5.

Table 5. Student Interview Analysis on the Integration of Environmental Sustainability into General Education Courses

Theme	Summary of Common Views	Selected Student Quotes
1.Practical Experience Enhances Understanding and Empathy	Students believe that through outdoor activities, manual labor, and contact with nature, they gain a deeper understanding of environmental issues and enhanced intrinsic motivation.	Interview A3–4: "Through hands-on and experiential learning, students can more concretely understand environmental problems… and become motivated to engage in conservation." Interview C2–3: "This course allowed us to physically experience the hardship and value of environmental protection." Interview E4–5: "It's not only about using our hands… but also about seeing the relationship between people and the land." Interview G1–2: "Compared to classroom lectures, we can actually participate and do things ourselves." Interview H2–3: "It feels nice to have a course that lets me engage with the outdoor environment."
2.Environmental Sustainability Should Begin with Student Education	Students believe that environmental responsibility should be cultivated through education, which can then influence society.	Interview A2–3: "If students lack awareness of sustainability… it could negatively affect social development." Interview B1–2: "During their academic years… students should become aware of the issue and take concrete action." Interview D1–2: "Environmental sustainability should start with student education… we can influence the bigger picture."
3.Integrating Environmental Sustainability into General Education Is Valuable	Students expressed positive views on course design, believing that sustainability issues should be formally included in general education and paired with practical application.	Interview B2–3: "This content should be directly integrated into the curriculum… it's more effective than online advocacy." Interview D6–7: "Using general education courses is a good choice… it allows students to learn from multiple perspectives." Interview E1: "This is a very worthwhile course design to promote." Interview F1: "I believe the idea of integrating 'environmental sustainability practices' into general education is worth promoting." Interview G2–3: "Incorporating environmental sustainability into general education is great… it gave me a deeper understanding of the issue."

The six interview questions for the STEAM exploration in this study were formulated based on activity design, educational experience, community of practice,

learning measurement, learning space, and social and cultural environment (Luo, 2023). After the interview transcripts were explored for each topic, the thematic analysis method was used to obtain Q1 deleted "Environmental sustainability must start with student education", Q3 deleted "mutually beneficial relationships and practical learning" and "systemic structural dependence", Q4 "design and aesthetic professional practice", "contributions of non-directly related departments", "technology application and future development suggestions", Q5 "career imagination and professional connection", Q6: "emotional connection and environmental identity", "building community and emotional belonging". The following research results were obtained. Each interview question outline analyzed the representative "themes", and the student narratives represented were omitted here due to space limitations, as shown in Table 6 below.

Table 6. Analysis of STEAM-6E Environmental Sustainability Practice in University General Education Courses

Interview Question	Theme	Representative Students
Q1. Integration of Environmental Sustainability into General Education	Practical experience enhances understanding and empathy	A, C, E, G, H
	The value of integrating sustainability into general education	B, D, E, F, G
Q2. Experience of Serving at the Grand Manor Farm	Self-benefit (Personal growth)	A, B, C, E, F, G
	Altruism (Helping and contributing to others)	A, B, C, D, E, F, G
	Environmental benefit (Sustainable practice)	A, C, D, E, F
Q3. Environmental Industry's Reliance on Volunteers	Human resource dependence	A, C, E, F, G, H
Q4. Application of Professional Background	Application of engineering/logical skills and systemic thinking	E, F, G
	Professional skills not applied but reflective potential	B, D, H
Q5. Impact on Career Development	Soft skills improvement (communication, sense of responsibility)	B, C, D, E, F, G, H
	Problem-solving and observation skills	C, E, F
	Endurance and stress resilience	B, C, E, F
Q6. Analysis of Participation Motivation	Tangible incentives and reward systems	A, F, H
	Fun and experiential design	C, E, F, G
	Sense of achievement and visible outcomes	C, E, G
	Professional integration and career relevance	D, E, F

4. Conclusions

This study adopted the STEAM-6E instructional model and an environmental sustainability practice course design, combining classroom teaching with outdoor service-learning, to explore how university students in general education courses understand and translate sustainability issues into action. The results indicate that through hands-on experiences, teamwork, and reflective writing, students showed significant growth in physical participation, emotional engagement, and value internalization. These experiences

further enhanced their problem-solving abilities, interdisciplinary competence, and environmental responsibility. Interview and reflection data revealed that students demonstrated care for individuals, communities, and nature, along with an emerging capacity to implement sustainable concepts in practice. The study also highlights that practice-oriented courses can help bridge the gap between policy and learning, transforming education from knowledge transmission to action-oriented engagement. Future general education should continue to incorporate experiential learning and interdisciplinary collaboration to cultivate modern citizens with critical thinking skills and sustainable action competence.

The limitation of this study is that although the sample size is small, it is representative and indicative. Even though the sample size is limited, the research subjects are information-rich, and the experience of outstanding students is typical and critical. The phenomena presented by these students can not only serve as subsequent theoretical construction and educational practice, but also as indicators and references for environmental sustainability. Further studies could investigate differences in students' understanding of sustainability issues across various disciplines and institutional settings, improving the generalizability and comparability of results. It is also suggested that longitudinal research be conducted to observe whether students continue to practice sustainability in their daily lives after course completion. This study is scheduled to conduct questionnaires, interviews or reflection records 3 to 12 months after the end of the course, focusing on whether students actively practice and whether their actions are combined with their self-identity. This will help evaluate whether the impact of this course is long-term, and optimize the "Evaluate" and "Evolve" stages in STEAM-6E to strengthen the continued impact of teaching. Additionally, integrating digital tools to document the learning process and conducting mixed-method (quantitative and qualitative) analyses could provide deeper insights into the long-term impacts of the STEAM-6E model on students' agency and interdisciplinary competence, thereby optimizing instructional design and implementation strategies.

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