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The Role of the Green Economy Approach in Developing Teaching and Learning for Sustainable Development Among Egyptian STEM Candidate Teachers

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ABSTRACT
With the growing concern over major environmental issues, higher education institutions have increasingly focused on equipping students with the knowledge and skills to address these challenges. One effective approach is the integration of the green economy into education, which can contribute to reducing environmental problems. This study aims to identify the extent to which the green economy approach is applied in sustainable development within the Faculty of Education at Assiut University and its significance in developing teaching and learning processes in university education. A mixed-method approach was employed, utilizing both a questionnaire and interviews administered to a sample of 126 STEM student teachers and nine faculty staff members. The findings reveal that students' perceptions of the role of the green economy in sustainable development were highly positive, with a mean score of 2.271 and a standard deviation of 0.512. This shows that integrating this approach can support the university in fostering a green educational environment, promoting green thinking and training, and strengthening green community engagement. Additionally, faculty members emphasized the necessity of establishing new policies for university teaching and learning to facilitate the transition to a green economy, ensuring the achievement of sustainable development goals.

KEYWORDS
Green economy; teaching and learning; sustainable development; STEM student teachers.

INTRODUCTION

A shift towards a green economy is one of the most critical local and global challenges facing higher education due to its impact on both the economy and the environment. Countries worldwide have started various initiatives to embrace and invest in this economic model. The Egyptian government has made commendable strides in transitioning to and supporting the green economy. Ultimately, Egyptian universities should prioritize environmental responsibility by embracing this model and contributing to the global transition toward a sustainable, clean economy that ensures a decent standard of living for all. The primary challenge lies in securing sufficient funding from local and international sources to support necessary facilities, research, and development initiatives. Additionally, effective institutional and policy frameworks are essential for coordinating efforts amongst various government agencies and enforcing regulations. Addressing social equity concerns and ensuring that the benefits of the green economy reach marginalized and vulnerable populations are equally important (Muhammad, 2022). These challenges require university education to undergo a rapid transformation in its orientations, processes, references, roles, and functions to effectively contribute to sustainable development (Blose, 2025; Ngare et al., 2022; Sung & Choi, 2022). In light of these considerations, university education should align with Egypt Vision 2030's sustainable development strategy to support the country's economic, social, and environmental progress. Egypt Vision 2030 prioritizes justice and social integration to improve living standards and quality of life. Moreover, addressing climate change, investing in human capital, and achieving sustainable economic growth are central objectives of the vision (Hussein, 2022). The green economy has emerged as a key mechanism for achieving sustainable development (Salman et al., 2022; Xia & Haiyang, 2023). In response, Egypt has developed a strategic report outlining objectives to transition towards a green economy by stimulating and diversifying production sources, creating new job opportunities, and attracting investments that contribute to increasing average individual income while ensuring the efficient use of natural resources. Regarding green jobs, advancements in recycling, renewable energy, and sustainable agriculture are projected to generate eight million jobs by 2050. These projections are based on studies published by UNEP (2019) and the German Development Institute (2022) on the implications of Egypt's shift to a green economy (Houssam et al., 2023). Therefore, Egyptian higher education must prioritize the professional development of faculty members in green economy principles and approaches. Universities should equip students with essential green economy concepts and the skills necessary for their practical application in society. Additionally, faculties should establish teams dedicated to environmental initiatives, integrate green economy concepts into curricula and programs, and foster a campus culture committed to sustainability.

LITERATURE REVIEW

The green economy offers a new perspective on the relationship between the economic, environmental, and social dimensions of sustainable development, aiming to reduce poverty

and inequality while promoting overall well-being. It also facilitates the mobilization of support for sustainable development by adopting a framework that integrates these three dimensions (Abo-Khalil, 2024). The green economy seeks to advance social justice and economic growth while reducing ecological and environmental risks to achieve long-term sustainability. Egypt's green economy, through efforts to address environmental challenges, expand renewable energy, and create economic opportunities, has the potential to make a considerable contribution to sustainable development (Muhammad, 2022). The concept of a green economy is rooted in environmental economics, which examines the interaction between economic systems and natural ecosystems. This field focuses on balancing these interconnected systems while assessing the impact of economic activities on climate change and its consequences (Pinheiro et al., 2024; Zhang et al., 2022).

Some of the concepts closely related to the green economy

There are many concepts related to the green economy, including:

Environmental sustainability: Environmental sustainability is a fundamental dimension of sustainable development, often referred to as the 'environmental dimension'. Historically, this aspect has been overlooked in developmental planning, as many countries have prioritized economic growth without adequate consideration of environmental concerns. However, environmental sustainability is essential for maintaining interdependence, flexibility, and balance within society, ensuring that its needs are met without exceeding the capacity of natural systems to support and renew the essential services required for human well-being (Fallah et al., 2022). In essence, environmental sustainability enables natural systems to perform two basic functions. First, it ensures the provision of natural resources necessary for societal needs while maintaining their regenerative capacity. Second, it allows these systems to absorb pollution from human activities in a manner that safeguards human health, protects all living organisms, and preserves the ecosystem itself (Feigin et al., 2023).

Green education: green education, also referred to as environmental education, green school, green university, or sustainable education, is an educational approach that equips individuals with the knowledge and skills needed to address contemporary global issues, improve quality of life, and protect the environment. It aims to prepare citizens who understand the natural environment, recognize associated problems, and develop solutions to mitigate these problems (Akinsemolu & Onyeaka, 2025). Green education fosters environmental awareness by instilling knowledge about natural resources, their preservation, and the development of skills that enable learners to make informed decisions and take responsible actions regarding environmental issues. Additionally, it prepares graduates for green jobs, ensuring they understand the importance of resource conservation and sustainable utilization for environmental benefit (Xianjing et al., 2023). This emphasizes the necessity of integrating sustainability education across all scientific disciplines, a practice already adopted in fields such as management, environmental engineering, agriculture, geography, and science (Bernardo et al., 2023).In the Arab countries, numerous universities offer specialized programmers related to

environmental and sustainability studies, including Environmental Science, Environmental Science and Biochemistry, Environmental Engineering, Environmental Systems Design, Environmental Technical Management and Engineering, and Applied Geology and Environmental Science. Some of the leading countries providing these disciplines include Egypt, Jordan, Lebanon, Saudi Arabia, Bahrain, Kuwait, Oman, Morocco, Mauritania, and Libya. These specialized programs are available at various academic levels, including bachelor's, master's, and PhD degrees.

Green thinking and innovation: Green innovation involves developing sustainable processes or new environmentally friendly products, such as utilizing solar cells to harness the sun's abundant and renewable energy or improving the environmental efficiency of existing products. An example of this is Germany's cultivation of flowers in water instead of soil, which reduces the need for pesticides, herbicides, and fertilizers (Mondal et al., 2024). Additionally, the creative green university student plays an important role in green innovation, as they are equipped to generate innovative environmental solutions. Recognizing this potential, many companies actively seek to engage with these students and may even offer contracts while they are still pursuing their studies at university.

Green management: Green management requires several key elements, including effective administrative leadership, green strategic thinking, creative human capabilities committed to environmental sustainability, green knowledge management, a modern and efficient system for product development, and an integrated framework for environmental management (Khan, 2024). This underscores the importance of developing green university students in the field of management, as they are expected to become the green transformational leaders that the Arab world and various organizations will need both now and in the future. These students are also expected to take on green roles, contribute to innovative teams within organizations, and ultimately help build a comprehensive green knowledge repertoire.

Green jobs: Jobs related to the environment and clean energy involve protecting wildlife and ecosystems, reducing pollution and waste, and contributing to industries that produce environmentally friendly goods and services. These positions are offered by institutions committed to environmental preservation and sustainability (Tănasie et al., 2022). Al-Balushi

The green economy and its relationship to sustainable development

Sustainable development is defined as a set of development practices that meet the needs of present generations without compromising the ability of future generations to meet their own needs. It does not prohibit the use of economic resources such as water, oil, and forests but seeks to prevent their overexploitation to ensure that future generations retain access to these resources, particularly non-renewable ones like oil (Benwan, 2022). The green economy serves as a key mechanism for achieving sustainable development by offering numerous opportunities, including fostering innovation, creating new labour markets, generating employment, and contributing to poverty eradication. Additionally, it enables societies to bypass certain developmental stages by adopting advanced technologies to enhance food security, expand

energy access in rural areas, and improve essential services such as clean water supply, housing, sanitation, and public transportation, all of which contribute to job creation and poverty reduction (Houssam et al., 2023). Muhammad (2022) argues that Egypt's green economy has a positive impact on sustainable development by enhancing environmental quality, creating green jobs, and diversifying energy sources. However, several challenges hinder its full potential, including insufficient funding, inadequate infrastructure, and a lack of information and training related to the green economy. To maximize its impact on sustainable development, it is essential to implement clear policies and strategies that support investment in green sectors, foster innovation and environmental technology, provide financial support, and promote awareness and education. *Approaches to teaching sustainability and green economy*

1. Service-learning approach: Service learning has become an essential component of higher education, as it is believed to enhance student performance, encourage active citizenship, foster a "scholarship of engagement" among educators and institutions, promote social equity, and strengthen the relationship between colleges and their surrounding communities. However, despite the recent expansion of service-learning theory and practice, there remains a lack of clarity regarding its fundamental principles and objectives. Service learning integrates university education with community service, social activities, experiential learning, legal dimensions, and the effective use of educational technologies to create a more engaged and socially responsible learning environment (Álvarez-Vanegas, 2024).

2. Active Learning Approach: Active learning aims to enable learners to effectively acquire, integrate, and apply knowledge through cognitive engagement while fostering intrinsic motivation that supports the adoption of lifelong learning (Li et al., 2023; Mokotjo, 2024).

3. Deep Learning Approach: Deep learning encourages students to infer meaning and develop a profound understanding by critically reading and analyzing material, carefully considering concepts and terms, and effectively integrating accumulated knowledge, ideas, and scientific findings (Elbashbishy, 2024).

4. Problem-Based Learning Approach: Problem-based learning (PBL) fosters students' creative thinking, particularly in addressing sustainability issues, which are highly ambiguous and complex (Widiastuti et al., 2023). Additionally, adopting an interdisciplinary approach is essential, as sustainability encompasses interconnected challenges from multiple disciplines (Hao Yu, 2024). There is a need for student-friendly educational approaches to enhance learning, as sustainability requires integration across different sciences and between theory and practice. This necessitates innovative learning methods to help current and future students navigate the growing complexity of sustainability. Some effective approaches that encourage creativity in application include self-regulated learning, group learning, and research activities that engage students in critical thinking, whether through small classroom groups or research teams in practical settings. By integrating these strategies, university curricula can better prepare students to address complex environmental challenges and contribute meaningfully to sustainable development efforts (Uzorka, 2024).

Green economy and sustainable development in developing countries

Since its introduction in 2008, the Green Economy has gained substantial global attention, particularly after being utilized as a response to the financial crisis at the UN Conference on Sustainable Development in 2012. Its essential role has been recognized by both developed and developing countries due to its potential to reduce unemployment rates and alleviate poverty, especially in developing nations (Houssam et al., 2023). By 2030, while considering environmental sustainability alongside economic growth and development, several studies have examined the differences between developed and developing countries regarding the factors affecting green growth and the impact of the green economy on economic development in developing regions (Ferreira et al., 2023; He et al., 2022; Liu et al., 2023). To maximize green economic opportunities, governments should focus on increasing rates of green employment, green trade, green investment, and green innovation. Additionally, investments in scientific knowledge within higher education institutions are essential for fostering green skills. Consequently, a structured framework for job selection and recruitment should be developed to align with the demands of a green economy (Ferreira et al., 2023).

Context of the problem

A report by the United Nations Environment Program (UNEP) at the United Nations Conference on Sustainable Development highlighted the critical need for investment in education, training, and capacity building to improve skills and prepare the workforce for the transition to a green economy. Addressing the skills shortage requires the development of educational programs with a new vision that promotes sustainable development, and university curricula should integrate this perspective. Several studies have emphasized the need for universities to adopt the green economy approach for sustainable development in teaching and learning processes (Akinsemolu & Onyeaka, 2025; Feigin et al., 2023; Hassan, 2022;). Based on the researcher's experience in academic activities related to the environment, it has been observed that students often lack knowledge about the green economy and its connection to sustainable development, along with minimal participation in green environmental activities during their studies. These issues point to a gap in university students' understanding of sustainable development concepts. Consequently, the current research problem has been formulated to address this gap and seeks to answer the following main question: *What does the green economy contribute to enhancing teaching and learning in sustainable development among STEM student teachers at the Faculty of Education, Assiut University?* A set of sub-questions arise from the main research question, namely:

1- What is the concept of green economy and its approaches in higher education?

2- What is the current state of applying the green economy approach in teaching and learning among STEM student teachers at the Faculty of Education, Assiut University, to achieve sustainable development?

3- What are the suggested strategies for improving the teaching and learning process in sustainable development in light of the green economy approach for STEM student teachers at the Faculty of Education, Assiut University?

Study objective

The research aims to identify the concept of the green economy in higher education and its role in enhancing the educational performance of students at the Faculty of Education, Assiut University, particularly in the context of sustainable development. This was explored through the perspectives of a representative sample of STEM student teachers and selected faculty members. Additionally, the study seeks to develop recommendations for improving the teaching and learning process in sustainable development by integrating the green economy approach for students at the Faculty of Education at Assiut University.

Significance of the study

The significance of this research lies in its focus on university students' perspectives on the importance of achieving sustainable development within the framework of the green economy, ultimately contributing to the enhancement of their educational performance. Also, the research examines the faculty members' perceptions on achieving sustainable development.

METHOD

The nature of the research required the use of a descriptive-analytical design, as it is one of the most suitable research methodologies for examining, analyzing, and evaluating the current situation while also providing insights for future projections (Siedlecki, 2020).

Study sample

The research representative sample consisted of 125 STEM student teachers (both male and female) from the Faculty of Education, selected using a random sampling method. The aim was to assess the extent to which the green economy approach is applied in developing teaching and learning to achieve sustainable development at Assiut University. The distribution of the research study sample is presented in Table 1.

The study also included nine faculty members from the Faculty of Education at Assiut University to gather their perspectives on the importance of applying the green economy approach in developing teaching and learning processes to achieve sustainable development.

Table 1.

Study Sample Size

Year	Study population	Sample	percentage of the study population
First	47	35	74.47
Second	64	60	93.75
Third	42	30	71.43
Total	153	125	81.70

Delimitations

The study is delimited to the following:

Thematic delimitation:

This research focused on clarifying the importance of the green economy approach and its role in developing the teaching and learning processes of students at the Faculty of Education, Assiut University, within the context of sustainable development.

Human delimitation: The study sample consisted of undergraduate STEM student teachers at the Faculty of Education, Assiut University, along with selected faculty members.

Spatial delimitation: The research was conducted at the Faculty of Education, Assiut University.

Temporal delimitation: The field research tools were applied during the first semester of the 2023/2024 academic year, with interview durations ranging from 15 to 20 minutes.

Data Collection

Research instruments

a. The questionnaire:

The researcher employed a questionnaire developed based on the theoretical framework of previous studies, which was administered to a representative sample of STEM student teachers at the Faculty of Education, Assiut University. The sample consisted of 40 male and female students and aimed to assess the extent to which the green economy approach is used in developing teaching and learning among students at the Faculty of Education, Assiut University. The final version of the questionnaire consisted of three main dimensions, categorized as follows:

The first dimension**:** Green educational environment, which includes nine statements.

The second dimension**:** Green thinking and training, which includes 11 statements.

The third dimension**:** Green Community Communication, which includes 10 statements.

To ensure the content validity of the questionnaire, it was reviewed by a jury of five professors from the Faculty of Education at Assiut University. Their evaluation aimed to assess the questionnaire based on the following criteria:

- The questionnaire statements are suitable for the main objectives of the research.
- The extent by which each statement is related to the dimension to which it belongs.

Table 2

Reliability of the Questionnaire

Dimension	No. of items	Reliability Cronbach's alpha
Green educational environment	9	0.732
Green thinking and training	11	0.865
Green community communication	10	0.813
Total score	30	0.825

Based on the feedback from the jury members, certain phrases were modified, and those with less than 90% agreement were removed. To ensure the reliability of the questionnaire, Cronbach's Coefficient Alpha was employed. The questionnaire was administered to a pilot sample of 30 male and female students, who were excluded from the main study sample, as presented in Table 2.

Source: Prepared by the researcher based on the outputs of the SPSS.V.22 program

The calculated Cronbach's alpha was 0.99, a high value that is statistically significant at the 0.01 level. As presented in the previous table, the overall Cronbach's alpha coefficient for the questionnaire was 0.825, indicating strong reliability and suitability for the research objectives. Additionally, Cronbach's alpha coefficients for each dimension were also high, confirming their appropriateness for the study. Therefore, the final version of the questionnaire was deemed valid and reliable for application.

b. The interview

1) Interview design

2) The interview was designed by developing a set of open-ended questions focused on the nature of the green economy and proposals for maximizing its benefits to develop education and learning in pursuit of sustainable development. It consisted of two main parts: the first part gathered background information, including job title, academic degree, gender, and years of experience, while the second part comprised the core interview questions related to the study's objectives. Steps for constructing interview questions

3) The researcher followed these steps: reviewing literature and previous studies related to the research topic to inform the definition and formulation of the interview questions. A jury of five professors from the Faculty of Education at Assiut University was consulted during the preparation process, leading to modifications through deletion and addition until the interview reached its final form. Preparing for the interview

The researcher adhered to a set of requirements in conducting the interviews: selecting nine faculty members involved in teaching STEM student teachers as participants, conducting the interviews via Zoom, and considering participants' availability when scheduling. Each interview lasted between 15 and 20 minutes, allowing participants the flexibility to choose a convenient time.

Data analysis

After administering the questionnaire to the study sample, the researcher applied descriptive statistical methods using the Statistical Package for Social Sciences (SPSS v.22). The following analyses were conducted:

A-Descriptive Statistical Measures: Used to answer the study questions and rank the study variables based on their importance by calculating arithmetic means and standard deviations.

B- Cronbach's Alpha test: Employed to determine the reliability of the questionnaire items.

RESULTS

Descriptive statistical measures were applied to answer the research questions, specifically the arithmetic mean and standard deviation, using a three-point Likert scale to analyse the responses of the study participants to the questionnaire dimensions. An arithmetic mean ranging from 1 to 1.66 indicates a low level of importance, a mean between 1.67 and 2.33 represents a medium level of importance, and a mean between 2.34 and 3 signifies a high level of importance. To answer the main study question, the results were analyzed as follows:

1. Main study question: 'What is the current state of applying the green economy approach to develop the teaching and learning process in achieving sustainable development amongst Assiut University students?' Analyzing the study participants' responses to the items of the green thinking and training dimension:

Table 3 (see appendix).

2. The study sample's responses to the 'green thinking and training' dimension were highly significant, with a mean score of 2.429 and a standard deviation of 0.521. The responses to item (6) showed a particularly high significance, with a mean of 2.678 and a standard deviation of 0.504, confirming that the Faculty of Education has taken steps to reduce the use of paper and textbooks. Notably, an internal administrative decision was issued to encourage communication among different departments through WhatsApp and to rely on electronic sources instead of printed books, which strongly supports sustainable development. Item (9) ranked second, showing that the faculty organizes scientific forums and conferences on green economy issues to address climate change in collaboration with the Community Service and Environmental Development Sector. In addition, the first forum for environmentally friendly projects was held, with participation from faculty members and teaching staff in the STEM division. Furthermore, the first Green Dream Student Conference took place, where STEM student teachers participated and won two prizes for presenting their projects. This reflects the university's commitment to promoting a culture of the green economy in support of sustainable development among its students. This commitment is further confirmed by the remaining items in the dimension, including items (1), (2), (3), (4), (5), (7), (8), (10), and (11). The Faculty of Education organizes awareness meetings for students on rationalizing environmental resource consumption in alignment with sustainable development policies, as well as seminars on carbon footprint and climate change. Additionally, students are encouraged to develop innovations related to the green economy in collaboration with the university's innovation unit, linking these efforts to entrepreneurship. This aligns with the findings of Ferreira (2023), who emphasized the importance of annual forums and conferences focused on environmental sustainability. Moreover, Assiut University held the first student conference, 'The Green Dream', in November 2023, with participation from students across various faculties. Additionally, the 'Environmentally Friendly Projects' forum, held in May 2023 with faculty participation, further shows the university's commitment to spreading the culture of the green economy. The above-mentioned results align with the findings of Xiao (2024), who underscored the importance of

assessing education programs for sustainability to identify best practices in sustainability education. Additionally, examining the effect of the green economy in education can provide valuable insights that support the establishment of sustainable investments. Analyzing the study participants' responses to the items of ’the green educational environment’ dimension:
Table 4 (see appendix).

The study sample's responses to the ’green educational environment’ dimension were highly significant, with a mean score of 2.393 and a standard deviation of 0.564. This confirms the establishment of a green educational environment for students at the Faculty of Education, Assiut University, and its major role in enhancing teaching and learning processes. The responses to the remaining items in this dimension, including items (1), (2), (4), (5), (6), (7), (8), and (9), were also highly significant, with mean scores ranging from 2.534 to 2.375. This confirms that the faculty priorities waste classification and energy conservation by utilizing energy-saving bulbs. Additionally, the Faculty of Education is characterized by the presence of ample green spaces, contributing to a sustainable educational climate. Furthermore, certain courses emphasize environmental sustainability, such as the environmental education course taught to students. The STEM program provided at the Faculty of Education reinforces interdisciplinarity between science, technology, engineering, and mathematics to develop environmentally friendly products, further supporting sustainability efforts in education.

With an arithmetic mean of 2.242 and a standard deviation of 0.563, item (3) had a moderate level of significance. This suggests a need for greater integration of green technology to develop green infrastructure, which would further enhance the achievement of sustainable development. This finding aligns with the research conducted by Xu, W., Shang, Y (2025), which highlighted the positive role of educators and learners in adopting the green economy to support the development of infrastructure that promotes sustainability.

3. Analyzing the study participants' responses to the items of “the green community communication” dimension:

Table 5 (see appendix).

The study sample's responses to the ’green community communication’ dimension were highly significant, with a mean score of 2.358 and a standard deviation of 0.520. These results confirm the Faculty of Education's role in fostering green community communication and implementing practices that support sustainable development. This aligns with the findings of Uzorka et al. (2024), which emphasized the importance of strengthening collaboration between educational institutions, local communities, and authorities to increase access to high-quality education in the field of the green economy. Similarly, Ristanović et al. (2024) emphasized the importance of promoting green endowments and green endowment funds, allocating their returns to invest in environmentally friendly development projects, and encouraging investment in sustainable economic sectors.

The study sample's responses to the remaining items in the ‘green community communication’ dimension, including items (1), (2), (3), (4), (6), (7), (9), and (10), were highly

significant, with mean scores ranging from 2.616 to 2.394. This confirms that the Faculty of Education actively promotes its environmental activities through its website and social media platforms, encouraging student participation in environmental initiatives. One such example is the first student environmental league competition held at Assiut University, aimed at spreading environmental awareness and fostering student engagement in exchanging environmental and community-related information and experiences. These findings align with the studies of Hassan (2022) and Ukamaka (2024), which highlighted the importance of reshaping and refining economic activities to be more environmentally supportive and contribute to sustainable development. Meanwhile, items (5) and (8) showed a moderate degree of significance, indicating the need for the faculty to establish more agreements with scientific research centers to advance sustainable development. Additionally, there is a need to further promote academic student exchange programs in the field of green energy as a means of addressing complex environmental challenges.

In summary, the data presented in tables (3, 4, and 5) show that the Faculty of Education at Assiut University demonstrates a high level of commitment to the green economy in support of sustainable development. The mean score of students' responses regarding the implementation of the green economy at the faculty was 2.371, with a standard deviation of 0.542, indicating a moderate level of significance. The ‘green thinking and training’ dimension ranked first, with an arithmetic mean of 2.429 and a standard deviation of 0.521, highlighting the emphasis on developing students' thinking in the field of the green economy. This also reflects the faculty’s adoption of policies that enhance sustainable development and its focus on training programs that equip both faculty members and students with green economy skills, integrating them into the university’s teaching and learning processes. The ‘green educational environment’. dimension ranked second, with an arithmetic mean of 2.393 and a standard deviation of 0.564. This indicates that students, after obtaining relevant knowledge, are capable of fostering a green educational environment by integrating green sustainability concepts to support teaching and learning for sustainable development. Additionally, this dimension underscores the importance of providing applied green educational activities, developing contemporary majors and programs related to the green economy and promoting sustainable development initiatives within the university.

The dimension ’green community communication’ ranked third, with an arithmetic mean of 2.358 and a standard deviation of 0.520. This confirms the faculty's ability to apply knowledge and skills by integrating them into the university learning community through effective communication with other students and faculty members. Additionally, it highlights the faculty’s engagement with the local community surrounding the university campus by organizing awareness seminars, participating in environmental events, and promoting the adoption of renewable energy sources to reduce environmental issues. However, there remains a need for the faculty to establish more agreements with scientific research centers in economic

fields and to enhance academic exchanges to further develop students' educational performance in the green economy, ultimately supporting greater sustainable development.

4. Analyzing the study sample participants' opinions

The researcher gathered the opinions of faculty staff members regarding suggestions for enhancing the teaching and learning process in sustainable development within the framework of the green economy approach for Assiut University STEM student teachers. This was achieved through individual interviews with nine faculty members.

DISCUSSION

The aim of this study was to identify the extent to which the green economy approach is applied in sustainable development among student teachers at the Faculty of Education, Assiut University, and to determine its significance in developing teaching and learning processes in university education. The findings highlight the importance of integrating the green economy approach into higher education, offering insights into aligning educational goals with green economy principles and preparing students for green jobs in the labour market. These results align with the research of Uzorka et al. (2024), which confirmed that implementing the green economy approach and sustainable development requires improving and enhancing the quality of education. Furthermore, the study underscores the necessity of developing environmentally friendly curricula based on successful international and regional experiences that support innovative student activities in sustainable development. This can be achieved by organizing workshops to train teachers in applying green economy approaches, a finding consistent with Al-Balushi (2022), who emphasized the need to provide financial and moral incentives for faculty members to incorporate green communication principles into their courses. Additionally, the study highlights the importance of strengthening partnerships with organizations and institutions engaged in the green economy and sustainable development. It also stresses the need to integrate global programs that equip students with the necessary skills for green jobs, ensuring that future generations are better prepared to contribute to global sustainability targets. These study results align with the findings of Tănasie et al.(2022), who emphasized the need to promote societal awareness of sustainable transport, eco-friendly building practices, and green electricity production. Similarly, the results are consistent with the study by Tabuenca et al. (2023), which highlighted the benefits of integrating plants and Internet-of-Things technology in teaching and promoting environmental awareness among university students. This confirmed the importance of incorporating green thinking and training into university education, emphasizing their crucial role in developing teaching and learning processes. Additionally, these findings align with the studies of Al-Dayeri and Ambusaidi (2022), Ukamaka (2024), and Hao Yu (2024), all of which stressed the importance of establishing training programs that equip students with the knowledge, values, and skills necessary for sustainability. Similar conclusions were drawn by Weis and Nikolić (2024), Xu and Shang (2024), who highlighted the importance of green innovation, encouraging entrepreneurship, supporting

creativity, and encouraging scientific research, development, and green technology. Furthermore, Hamd and Ibrahiem (2023) emphasized that the green economy serves as a foundational step towards shaping the future of university faculties, enhancing their competitive position in the educational field, and pioneering the implementation of green economy strategies within higher education institutions.

CONCLUSION

This study highlights the importance of incorporating green economy principles into higher education curricula, providing valuable insights into aligning educational objectives with green economy concepts and the growing demand for environmentally focused jobs. Additionally, it underscores the necessity of creating eco-friendly educational programs inspired by successful global and local initiatives that promote innovative student engagement in sustainable development practices. One proposed approach to addressing this need is organizing educational sessions that provide teachers with the skills needed to implement green economy principles into their instruction. The study also emphasizes the importance of collaboration with organizations and institutions involved in sustainable development and green economy initiatives. Furthermore, it advocates for the adoption of global programs designed to equip students with the skills necessary for green careers, ensuring that future generations are well-prepared to contribute to global sustainable development goals. These findings reinforce the role of critical thinking and sustainability education in higher education, highlighting their profound impact on enhancing teaching and learning within the university setting.

Limitations

As with most studies, the design of the current study has certain limitations. First, the study included only a sample of students from one Egyptian university due to time constraints and the limited implementation of green economy principles across the entire university education system. Previous research suggests that data collected from multiple universities can provide more meaningful and precise insights into how students develop connections to environmental sustainability through education. This is particularly relevant given population growth in rural areas and the increasing importance of interdisciplinary education in addressing contemporary societal demands (Akinsemolu & Onyeaka, 2025; Gavari-Starkie, 2022). Therefore, future research may expand on the findings of this study by including students from various Egyptian universities across different regions, such as the South, North, and Middle of Egypt. Second, the cultural background of the study presents another consideration. In the STEM education system, teachers play an important role in guiding students to integrate green economy principles into their coursework. Compared to traditional education systems, STEM education considerably contributes to fostering environmental sustainability among students and the broader community while equipping them with the skills needed for a smooth transition to a sustainable society (Beek & Straub, 2024; Jesús et al., 2022; Okwara & Henrik Pretorius, 2023). To build on the results of this study, future research could include samples from various cultural

backgrounds and conduct comparative analyses to explore variations in green economy integration across diverse educational contexts.

Recommendations*:*

Regarding green education and learning policies, the following recommendations are suggested:

- Establishing a clearly defined educational philosophy that aligns with societal values and integrates green economy principles into the education and learning system.
- Preparing graduates who are adaptable to environmental changes and transformations, ensuring they have the necessary skills to contribute to sustainable development.
- Creating new policies to redirect various university sectors towards adopting the green economy approach in alignment with national sustainable development priorities.

Regarding the goals of green university education, the following recommendations are suggested:

- Aligning university education objectives with green education approaches and labour market demands to support sustainable development.
-Implementing strategies to achieve green education goals and integrating them into student activities within university education.

Regarding green curricula, the following recommendations are suggested:

- Designing and developing curricula that align with the principles of the green economy and sustainable development.
- Integrating environmentally friendly project-based activities into the curriculum to enhance practical learning.
- Transforming economic systems programs to incorporate green economy principles, requiring a high level of innovation, expertise, and collaboration among various institutions and organizations.

Regarding the green teacher, the following recommendations are suggested:

- Training teachers in strategies for integrating green economy principles into students' curricula.
- Encouraging creativity and research innovation amongst teachers in the field of the green economy and sustainable development.
- Implementing student activities that highlight the positive impact of applying the green economy as a key pathway towards achieving sustainable development.

Regarding the management of green university education, the following recommendations are suggested:

- Attracting donors and supporters to enhance the efficiency of teaching and learning processes in alignment with green economy principles.
- Establishing collaboration between universities engaged in green economy initiatives to foster knowledge exchange and best practices.

- Integrating international programs into student training to equip them with the skills required for green jobs, ensuring the development of a well-qualified generation committed to environmental protection.
- Designing environmentally friendly curricula based on successful international and regional experiences in green economy education.
- Developing legal regulations that promote sustainable behaviors, productivity, and consumption patterns within Egyptian universities.
- Establishing a green economy unit in each faculty to create and sustain a green learning environment.
- Converting all campus buildings and laboratories into green learning environments to ensure a more sustainable university infrastructure.

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APPENDIX

Table 3

Responses of the Study Participants to the Items of the 'Green Thinking and Training' dimension

No	Item	Mean	St. D.	Relative Imp.	Level
1	My faculty holds awareness meetings for students on rationalizing the consumption of environmental resources in line with sustainable development policies.	2.342	0.524	10	High
2	My faculty holds workshops on recycling waste to sustain environmental resources on campus.	2.346	0.657	9	High
3	My university encourages participation in local and international competitions to innovate waste recycling systems and reduce societal waste production.	2.518	0.557	3	High
4	My faculty encourages staff members and students to develop green projects for sustainable development.	2.402	0.650	7	High
5	My faculty implements a green procurement policy to reduce environmental resource waste.	2.348	0.582	8	High
6	My faculty minimizes the use of paper and textbooks.	2.724	0.659	1	High
7	My faculty organizes green economy skills training programs for staff to develop sustainable education programs.	2.340	0.550	11	High
8	My faculty trains students in new green job requirements to enhance employability.	2.485	0.634	5	High
9	My faculty organizes scientific forums and conferences on green economy issues to address climate change.	2.634	0.536	2	High
10	My faculty promotes the transformation of green knowledge and skills into eco-friendly innovations.	2.504	0.504	4	High
11	My faculty arranges international trips to train students on successful green universities' sustainability practices.	2.418	0.637	6	High

	The dimension as a whole	2.429	0.521	High

Table 4

Responses of the Study Participants to the Items of the 'Green Educational Environment' Dimension

No	Item	Mean	St. D.	Relative Imp.	Level
1	My university features environmentally friendly green buildings.	2.420	0.568	7	High
2	My university has enough green spaces to provide a sustainable, pollution-free learning environment.	2.453	0.620	5	High
3	My university is developing eco-friendly infrastructure to integrate green technology for sustainable development.	2.242	0.563	9	High
4	My university promotes a green sustainability culture to achieve the goals of Education for Sustainable Development (ESD).	2.441	0.556	6	High
5	My university's curriculum includes services, systems, and green design processes.	2.502	0.607	4	High
6	My university is introducing new majors and programs related to the green economy.	2.508	0.554	3	High
7	My university encourages eco-friendly behaviour among students.	2.513	0.531	2	High
8	My university provides hands-on activities demonstrating the effectiveness of recycling systems in conserving environmental resources.	2.534	0.657	1	High
9	My university supports student research in green economy fields, aligning with Assiut University's sustainability policy.	2.375	0.569	8	High
	The dimension as a whole	2.393	0.564	High	

Table 5

Responses of the Study Participants to the Items of the 'Green Community Communication' Dimension

No	Item	Mean	St. D.	Relative Imp.	Level
1	My university organizes electronic media programs to address environmentally harmful behaviors and promote a sustainable environment.	2.522	0.567	3	High
2	My university leverages environmental events to spread green awareness and establish a sustainable green society.	2.613	0.554	1	High
3	My university distributes brochures and guides on the importance of green transportation to reduce carbon emissions and pollution.	2.454	0.568	6	High
4	My university collaborates with local organizations to raise awareness about recycling and waste sorting to conserve natural resources.	2.501	0.635	4	High
5	My university signs agreements with academic research centers specializing in the green economy to improve sustainability metrics.	2.394	0.678	8	High
6	My university establishes agreements with municipalities and local authorities.	2.593	0.751	2	High
7	My university forms international green partnerships to introduce green technology for better environmental resource management.	2.294	0.723	9	High
8	My university engages in academic exchanges to improve its performance in green energy as a solution to various environmental challenges.	2.221	0.542	10	High
9	My university organizes field visits to water treatment plants to promote green sustainability principles among students.	2.434	0.660	7	High
10	My university educates local community organizations on the benefits of renewable energy to reduce environmental problems.	2.485	0.568	5	
	The dimension as a whole	2.358	0.520	High	