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RESEARCH ARTICLE

SUSTAINABLE FUTURES THROUGH INNOVATION AND EDUCATION: A GREEN TECHNOLOGY APPROACH

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ABSTRACT

Green technology is regarded as one of the key elements that can minimize environmental quality degradation and contribute to a healthier environment. Additionally, its application in the field of education is considered crucial for fostering students' interest in valuing the environment. The knowledge learned by students can be practiced and disseminated to the community, promoting a more sustainable nation.This concept paper is intended to provide environmentally relevant information and sustainable development education (ESD), emphasizing the importance of green technology. This focus arises from the limited awareness of environmental conservation within the community. Consequently, environmental conservation awareness is seen as something that should be nurtured from childhood, as future generations are expected to drive significant change. The application of green technology as a driver of sustainable development education (ESD) is anticipated to contribute to addressing environmental issues. Moreover, Technical and Vocational Education and Training (TVET) is identified as having a significant role in advancing the greening of TVET, which is linked to green technology and ESD.

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INTRODUCTION

Sustainability is a pressing global priority that requires innovative solutions and collective efforts to address environmental challenges. Green technology and education play pivotal roles in this endeavor by fostering environmentally conscious behavior and sustainable development. Green technology drives advancements in renewable energy, waste reduction, and eco-friendly production, enabling societies to minimize their ecological footprint. Concurrently, education for sustainable development (ESD) and environmental education empower individuals with the knowledge, skills, and values needed to make informed decisions and take meaningful actions for a sustainable future. By integrating green technology with education, students and society can collaboratively drive innovation, promote sustainable practices, and achieve long-term environmental and economic resilience. This synergy is critical to creating a global culture of sustainability that benefits present and future generations. Green technology refers to the development and utilization of products, equipment, and systems designed to preserve the environment and resources while minimizing the negative impacts of human activities (KeTTHA, 2017; Monu Bhardwaj & Neelam, 2015). It encompasses methods and materials derived from techniques that generate energy and create non-toxic products (Green Technology, 2015). According to Karmilah Abdullah and Jamilah Ahmad (2014), green technology serves as an alternative to enhance the national economy without compromising the natural environment. Similarly, a study by Farahwahida Mohd Yusof, Arieff Salleh Rosman, Salwa Mahmood, Siti Hajar Mat Sarip, and Teh Ubaidah Noh (2013) highlights green technology, often referred to as clean technology, as a critical component of environmental science aimed at preserving nature and natural resources while mitigating the adverse effects of human activities. Ruzian Markom and Norizan Hassan (2014) further emphasize that green technology prioritizes environmentally friendly equipment and reduced carbon emissions, which play a vital role in combating global warming and ozone layer depletion. Sustainable Development Education (ESD) is a transformative form of education that addresses present and

future global challenges by fostering a sustainable and resilient society. ESD focuses on delivering quality education that upholds environmental integrity, economic viability, and social responsibility to empower current and future generations. According to UNESCO (2017), ESD adopts a holistic and interdisciplinary approach to learning, enabling individuals to develop resilience and a long-term perspective in decision-making processes. It encourages critical thinking, innovation, and holistic problem-solving. Moreover, ESD aims to equip individuals with the essential knowledge, skills, attitudes, and values required for a sustainable future (Devat S. Rathod, 2013).

METHODS

This study focuses on the integration of green technology into sustainable development education (ESD), with a particular emphasis on fostering environmental conservation awareness. The research will adopt a qualitative approach, involving case studies, interviews, and surveys to gather insights into the application of green technology in education. Technical and Vocational Education and Training (TVET) will be explored as a key sector driving the adoption of green technology and its impact on sustainability. Data will be analyzed to understand how green technology promotes environmental sustainability and its role in enhancing students' awareness and community engagement in sustainable development practices.

RESULT AND DISCUSSION

The results and discussion highlight how the integration of green technology in sustainable development education (ESD) enhances environmental awareness, promotes sustainability, and strengthens community engagement through innovative educational practices.

DETAILED ANALYSIS OF THE RESULT

Green Technology in Education: A Vital Component for Sustainability: The establishment of the Ministry of Energy, Green Technology, and Water (KeTTHA) has significantly accelerated the green technology revolution in Malaysia, elevating it from a slow pace of progress to a more advanced stage. The Ministry plays a pivotal role in promoting green technology across various sectors of development to facilitate an economic paradigm shift in alignment with Vision 2020. As part of this initiative, the government has analyzed curricula at preschool, primary, and secondary school levels to incorporate green technology education (Siti NorSyazwani, Mohd Safarin, & Muhammad Sukri, 2012).

In line with these efforts, a study by Farahwahida Mohd Yusof et al. (2013) emphasizes the importance of integrating green practices into daily life. Simple actions, such as carrying reusable water bottles instead of purchasing single-use plastic bottles or using personal containers instead of styrofoam, are examples of these practices. Encouraging such habits fosters an effective green lifestyle. Furthermore, technologies like waste combustion, composting, and recycling recyclable materials can help reduce waste and promote sustainability. Composting kitchen waste, for instance, can enrich soil health while minimizing environmental impact. Additionally, R.B. Mustapha (2015) highlights "greening TVET" (Technical and Vocational Education and Training) as a response to global sustainable development challenges. This approach supports the implementation of TVET programs aimed at enhancing sustainability, as advocated by UNESCO and the UNESCO-UNEVOC International Center over the last decade. The framework focuses on preparing TVET to contribute to a low-carbon and more sustainable global economy. Climate change, resource scarcity, and the effects of globalization have necessitated this green paradigm shift. TVET must address these challenges by equipping individuals with green skills to meet market demands and support social transformation sustainably. Kai Gleissner (2012) stresses the need to integrate greening concepts into TVET curricula. This involves revising existing subjects and incorporating practical training to develop new skills and competencies aligned with green industries. By introducing green methods and competencies, TVET can prepare a workforce adept at addressing environmental concerns. Malaysia is increasingly recognizing the importance of education and training in fostering a workforce equipped with innovative knowledge and technical skills to boost economic productivity. With its potential to advance green technology, Malaysia is striving to establish itself in the green industry, benefiting not only its economy but also social and environmental sustainability. Efforts toward green careers (Green Careers) reflect Malaysia's commitment to building a thriving green economy (Salina, Eza, & Azman, 2015).

Building Sustainable Futures Through Education: The ESD Agenda: Education for Sustainable Development (ESD) encompasses all levels of education, including kindergarten, primary, secondary, tertiary, and non-formal education. Schools play a pivotal role as models for promoting change and advancing ESD. The integration of students' life experiences into the school curriculum, including topics like food-related issues, consumer education, social learning, energy consumption, and personal resource management, is essential. Through such initiatives, young people can test and develop their life skills and adopt sustainable lifestyles (Reiner Mathar, 2013). Devat S. Rathod (2013) further highlights that ESD seeks to promote teaching that respects indigenous and traditional knowledge and encourages the use of native languages in education. To achieve this, sustainability perspectives must be incorporated into educational programs at all levels. Margarita Pavlova (2013), referencing the UNESCO report (2009), underscores the interconnectedness between Environmental Education (EE) and ESD. This relationship can manifest in three ways: EE being equivalent to ESD, EE being a component of ESD, or EE and ESD overlapping while remaining distinct. Regardless of the relationship, both are considered essential for fostering sustainability. R.B. Mustapha (2015) emphasizes the role of Technical and Vocational Education and Training (TVET) in promoting green development. Education and training for greening the economy and businesses must be implemented across all educational levels. At the foundational level, environmental education is crucial for creating awareness. The Palmer and Neal (1994) model is cited as an ideal framework for incorporating environmental education into basic-level curricula, laying a solid foundation for sustainability-focused learning.

Teaching For Environmental Sustainability: The Palmer and Neal (1994) model emphasizes that environmental education aims to cultivate knowledge about nature and natural systems through research activities. It also seeks to develop an understanding of the environment, environmental values, and

the complex interactions between natural and human elements (Norhusna, 2014). Schools, as educational institutions, are well-positioned to instill environmental awareness and foster attitudes among students that prioritize environmental preservation and conservation, shaping them into responsible human capital for a sustainable future. Arasinah, Ramlee, Norwaliza, and Bushra Limuna (2016) also highlight the Palmer and Neal (1994) model's focus on using research activities to deepen students' understanding of nature and environmental values. By integrating green technology elements, this model supports social and environmental activities through an environmental education framework. Adapting these educational approaches can enhance student engagement and awareness of environmental care. Furthermore, traditional teaching methods need to be revised to improve students' knowledge and practices regarding environmental sustainability. Encouraging activities like recycling and reusing products can help embed green technology principles into their daily lives, fostering a culture of environmental responsibility.

MANAGERIAL IMPLICATIONS: The managerial implications of integrating green technology and Education for Sustainable Development (ESD) emphasize the need for a holistic approach to education that incorporates sustainability into curricula at all levels. This approach promotes awareness, fosters practical green skills, and equips students with the competencies necessary to drive sustainable innovation and societal transformation. Additionally, greening TVET plays a crucial role in preparing a workforce aligned with sustainable development goals, ensuring that education contributes effectively to economic, social, and environmental sustainability.

CONCLUSION

Many previous studies have highlighted a lack of awareness within communities regarding environmental issues. However, implementing environmentally-focused education, particularly Sustainable Development Education (ESD), among communities—especially students—has the potential to significantly increase awareness of environmental care. Green technology can play a key role in ESD by incorporating products and practices designed to safeguard and preserve the environment. Additionally, Technical and Vocational Education and Training (TVET) is instrumental in integrating green technology and ESD, enhancing the skills of workers and learners while contributing to the development of a sustainable nation.

Environmental education models aligned with sustainable development and incorporating green technology elements are well-suited for students, addressing environmental issues effectively. Green technology, ESD, and environmental education are closely interconnected, as they collectively aim to empower students and communities to understand the importance of preserving and conserving the environment to mitigate global warming. The synergy of these three aspects not only addresses current environmental challenges but also inspires further research and innovation in green technology. As a key driver of sustainable development education, green technology holds immense significance for fostering environmental responsibility among students and communities.

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