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Eco-Friendly Basket: A STEM Project of Recycling Banana Stem

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Abstract

Eco-friendly products have become popular due to raising environmental concerns. This project aims to recycle banana stems into eco-friendly baskets and promote awareness of recycling organic material. This study was designed based on Sutaphan and Yuenyong (2019) context-based STEM education learning approach which consisted of 7 stages including (1) Identification of social issues, (2) Identification of potential solutions, (3) Need for knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage. Applying the STEM education learning approach enhances students' creativity and problem-solving skills. This project of recycling banana stems is essential to transforming non-value raw materials into eco-friendly products. The eco-friendly baskets are usable, attractive, and at the appropriate cost. Furthermore, teachers should integrate STEM education in their classrooms to promote effective learning activities, and this project could inspire people to recycle the raw materials in their current situation.

Keywords: STEM Education, banana stem, Recycle, Eco-friendly

1. Introduction

In the 21st century, there are seven core skills: technical, information management, communication, collaboration, critical thinking, problem-solving, and creativity. Furthermore, five contextual skills were identified ethical awareness, cultural awareness, flexibility, self-direction, and lifelong learning (van Laar et al., 2017). In responding to rapid economic development, education is a vital fundamental factor of development. Education is a significant factor in enhancing people's productivity, creativity, and technological advances. Additionally, it is essential in securing the economy and social progress. In this century, the rapid development of STEM education and research has been supported by many stakeholders, including government agencies, professional organizations, industries, and education institutions (Li et al., 2020). Otherwise, the purpose of the science curriculum is to ensure that the learners will acquire scientific

knowledge and skills, possess competencies in problem-solving, apply knowledge and skills in science for further study and daily life, recognize and appreciate the values of the subject of science and applications of science in national economic development (MoEYS, 2018). MoEYS has put a strong effort to reform and improve the quality of education. Particularly, develop human resources in STEM fields by strengthening STEM education (Factors Influencing Science and Social Science Stream Choices at Upper Secondary Education in Cambodia). In actuality, integrated learning can foster the connection between schools, communities, jobs, and global companies making it possible in the new economic world (Permanasari et al., 2021).

STEM is an acronym for science, technology, engineering, and mathematics, and it has significance in education, industry, innovation, and competition (Marrero et al., 2014). STEM education uses an interdisciplinary approach that integrates academic concepts, and a real-life situation by applying science, technology, engineering, and mathematics. STEM is a powerful teaching approach to enhance students' skills through authentic and real-life problem-solving (AlAli, 2024). STEM education is the key priority in curriculum change due to the increasing importance of the STEM field in national and global development (Tytler, 2020). Additionally, STEM education plays a crucial role in international economic competition (Kennedy & Odell, 2014). Students' creativity products are influenced by STEM knowledge that supports students' creativity and ability to solve daily problems associated with STEM (Mayasari et al., 2016). STEM professionals encourage students to solve complex problems and have multiple possible solutions. It is essential for secondary students because they gain broad knowledge that allows them to achieve on high-stakes tests, and reflect on the strengths and limitations of their solution. STEM project-based learning builds on engineering design that students apply knowledge of science, technology, and mathematics (Capraro et al., 2013). STEM education equips preservice science teachers with 21st century skills such as critical thinking, scientific process skills, problem-solving, creativity, communication, and collaboration. In addition, Preservice science teachers develop the scientific knowledge needed to solve the problem and awareness of interdisciplinary themes (Hacıoğlu, 2021). Furthermore, STEM projects engage students in authentic tasks that result in specific learning essentials in the current standards-based educational model and address future workplace learning needs (Capraro et al., 2013). By integrating STEM, students develop creativity skills and creative products (Mayasari et al., 2016).

The term recycles refers to a series of activities to collect recyclable materials and produce them into raw materials (Asmatulu & Asmatulu, 2011). Srieng et al. (2024) integrate STEM education to enhance student teachers' recycling of corn husks into decorative items (flowers). Eco-friendly products are safe or harmless for the environment (Isaacs, 2015). In the past decade, there were broad studies about the production of enzymes, antioxidants, and phenolic compounds through eco-friendly methods, which demonstrate the importance of recycling banana by-products as the potential resources for future development in the prevention of current economic and environmental problems (Kumar & Keran, 2022). Additionally, produce eco-friendly products from different parts of the banana plant such as leaves, stems, and fibers. In Asia, banana leaves have emerged as eco-friendly packaging (Atiq Juani & Navaranjan, 2023).

2. Developing STEM Education Learning Activities

The "go green" lifestyle has become popular due to the rapid environmental concern in the last few decades. In 1980, biodegradable polymers were introduced as a supplement to this trend. Biodegradable polymers are used as substitutes for plastic and other nonbiodegradable materials because of increasing awareness of environmental issues globally (Kumar et al., 2023). Over the past two decades, the natural fibers of plants and

animals have been extensively studied and become more important due to their biodegradability, renewability, and lightweight (Balda et al., 2021). Banana (Musa spp.) belongs to the Monocotyledons class, Zingiberales orders, and Musaceae family. Banana is grown in tropical and subtropical. In many countries of Africa and Asia, banana is a staple food crop (Heslop-Harrison & Schwarzacher, 2007). Since banana waste is widely available, and cost-effective as biorefineries for the extraction of significant commercial biopolymers with diverse use in different fields. The starch and cellulose were extracted from banana waste, and increased research on making products from biomaterials (Capraro et al., 2013). Otherwise, banana fiber is a valuable cost-saving, renewable, and environmentally friendly. This invention could reduce plastic consumption and maintain environmental health (Azman et al., 2021). Banana fiber is a natural fiber that has many benefits for producing varieties of handcraft such as mats, rope, and twins. However, only 10% of pseudo-stems are used for making products and the remaining become waste or used as fertilizer (Vigneswaran et al., 2015). Many studies indicated the advantages of banana fiber in physical and chemical properties which is a good raw material for the textile and packaging industry (Akatwijuka et al., 2024; Rahman et al., 2024; Fan, 2023).

Therefore, integrating STEM education into school is crucial because it has the potential to encourage students to apply scientific and relevant knowledge to design effective solutions to real-world problems (Koes-H et.al., 2021; Suparee & Yuenyong, 2021; Sutaphan & Yuenyong, 2023). Theerasan & Yuenyong, (2019) has developed a theoretical framework for STEM teaching strategies in school. Moreover, Sutaphan & Yuenyong (2019) has also designed STEM teaching approach consisted 7 stages such as 1). Identification of social issues, 2). Identification of potential solution, 3). Need for the knowledge, 4). Decision-making, 5). Development of prototype or product, 6). Test and evaluate the solution, and 7). Socialization and completion decision stage. Srieng et al. (2024) applied the 7 stages of STEM to the project for recycling corn husks and indicated that this STEM project significantly contributes to reducing cornhusk waste by using it as the raw material to create ornamental flowers. Meanwhile, banana stems are waste after harvest which should be recycled. Thus, the 7 stages of STEM education were applied in this STEM project.

2.1 Purpose of study

- Recycling the banana stem into an eco-friendly basket
- Raise awareness of environmental issues, recycling, and fostering problem-solving to respond to current challenges.

2.2 The activities of recycling banana stem with STEM education

The learning activities of recycling banana stems project through the 7 stages of the STEM education learning approach Sutaphan & Yuenyoug (2019). This project aims to address the issues of banana stem waste which remains after having its fruit. Our potential solution was recycling the banana stems into an eco-friendly basket. Our decision-making was based on the processing of the product, cost-effectiveness, environmental impact, and social benefit. The prototype was designed by hand-weaving. These products were promoted during the school exhibition. Furthermore, the products were evaluated on shape, attractiveness, environmental impact, and cost-effectiveness.

Table 1: Summarize 7 stages of the STEM education learning approach “Recycling banana stems”

Stage	Activity
(1) Identification of social issues	– Bananas provide many benefits such as fruit, leaves, and stems. However, banana stems become waste after harvesting, and don’t have economic value. The remaining banana stem waste has impacted the environment. – In society, the local community likely has less awareness of recycling the raw material into ornamental, and eco-friendly products.
(2) Identification of potential solutions	After finding this problem, our team has decided to recycle banana stems into eco-friendly baskets. Our team discussed the possible design of an eco-friendly basket regarding these aspects: – STEM (science, technology, engineering, and mathematics) – Raw materials: the sources and cost of raw materials – Social: find an appropriate solution for problem-solving and critical thinking. – Human: it is related to their satisfaction with products – Cost-effectiveness of products: Acceptable – Environment: This product promotes environmental sustainability.
(3) Need for knowledge	This project explores how to recycle the banana stem. Thus, we need to gather information from Google, YouTube, and articles as the basic concept. – Science: recycling the organic waste – Technology: researching the model of products – Engineering: Construct the model or product (handmade) – Mathematic: Calculate the size of products, – Economic: the cost of the product.
(4) Decision-making	– After we collected the relevant information, we presented our project plan to the lecturer. – We drew the model and drafted the design of the eco-friendly basket.
(5) Development of prototype or product	Processing of produce eco-friendly basket: • Break the banana tree into the small fiber by using the nails • Dry it under the sunlight • Dip in water to make it soft, and easy to compile. 
(6) Test and evaluation of the solution	The eco-friendly baskets were tested and evaluated regarding these criteria – Attractive: shape and size – Usable: easy to use and suitable storage space – Environmental impact: the raw material is biodegradable (no harm to the environment) – Cost-Effectiveness: appropriate cost of raw material.
(7) Socialization and completion decision stage.	– These products were presented at the STEM fair. We explained the processing of products and their benefit. – Participants were interested and bought these baskets.

	– We should promote widely through social media to enhance our critical thinking to make very environmental friendly products.   

3. Conclusion

By applying the seven stages of the STEM education learning approach, students can identify social issues, possible solutions and effective solutions which aligned to SDGs. This teaching approach allows them to apply STEM knowledge and skills to build creative products. This STEM project is significant to solving social issues, and environmental sustainability. Eco-friendly baskets are suitable for recycling banana stems. Eco-friendly baskets could be used instead of plastic bags, and the initiated reduction of plastic waste. This handicraft could be a job for the local community, and support their livelihood through selling products. In addition, it raises people's awareness of recycling raw materials and promotes eco-friendly product consumption. Furthermore, STEM education could equip students with the essential knowledge and skills in the 21st century such as technology, critical thinking, problem-solving, and creative skills.

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