

Assessing the Potential of Bamboo Education in Mainstreaming Climate Creativity to Undergraduate Architecture Students of Lower Middle-Income Country

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Abstract

This paper investigates the suitability of bamboo education in mainstreaming climate creativity to economically challenged architecture students. The case of the Polytechnic University of the Philippines' architecture department is used in this study since this is the only architecture program in the country that offers a specialization course on bamboo. Two methods were employed: first, through project output, in which the students had the freedom to focus on any issue in the built environment. Then, a survey was disseminated to assess students' recall of bamboo when climate change is the subject of discussion. Students gave attention to the impact of climate change on vulnerable communities, but their responses reflected a weak consideration of bamboo for climate action. Since the course aims for entrepreneurial opportunities, it influenced students' perception of bamboo merely as an eco-friendly material. While the goal is to educate students about their environmental and social responsibilities, it is unsuccessful when the association of bamboo to climate change is for them disconnected. This was evident in the responses where most of the students selected the other courses offered by the department. Students need to become confident that they can apply what they have learned in real-life situations and that there are opportunities beyond the classroom setting. Exposure to bamboo communities may open students' minds to the role of their creativity in advancing indigenous knowledge. Students will be able to grasp the real-life application of bamboo and learn about its successes and failures. Education is vital for students to realize that climate action is about complementing ecological approaches with social responsibilities.

Keywords: Bamboo, Climate Creativity, Sustainable Education, Undergraduate Architecture Indigenous Knowledge

Introduction

The urgency of climate change requisites the need for people to understand and address the impact of the climate crisis, empowering them with the knowledge, skills, values, and attitudes needed to act as agents of change (UNESCO, n.d.b). Particularly critical is the situation of urban areas in low and middle-income countries with severe development pressures and few resources and information to respond to the challenges of climate change (Sanchez-Rodriguez, 2011). The contextual limitations in developing countries (e.g., the lack of resources both in education and professional practice, inefficient legal framework, uncoordinated actions on all levels of governance, delayed spatial and economic development) are calling for a holistic approach to learning (Stupar, et a., 2017). Education for sustainable development entails integrating key sustainable development issues into teaching and learning, such as instruction about climate change (Mpofu-Hamadziripi, et al., 2022). It is vital to accelerate climate action as it influences human capacity which is about understanding the complex choices that sustainable development requires and motivating them to transform themselves and society (UNESCO, 2020). Education prepares future employees and employers to become the main drivers of economic activities that reduce carbon emissions, enhance resource efficiency, and prevent the loss of biodiversity. Updates to curricula across a diverse range of disciplines will be key to addressing climate adaptation to ensure professionals understand the impacts of climate change and the best practices for responding to them (Second Nature Education for Sustainability, n.d.). In addition, teaching initiatives combined with climate change research programmes, can make sure that universities are able to make their contribution towards addressing a problem, which is global in nature but whose impacts are mostly felt at the local level (Leal Filho, et al., 2021). By this, green skills which are the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society (Arthur, 2022) should be a fundamental part of education.

Exploitation of resources for the maximization of profit and the profound impact of design decisions on communities and ecosystems makes architecture culpable for climate destruction (Perison, 2023). Hence, the concept of climate literacy is crucial in architectural education. The term encompasses both scientific knowledge and sociocultural understandings of climate change which will need to be taught and learnt at architecture schools and then advocated in practice (Brogden et al., 2022). Typically, the socio-cultural aspects of sustainability are more difficult to both measure and take into account in architectural practice than are the environmental and economic ones (Sandman, 2021). The socio-cultural context of viewing science from indigenous perspectives might provide insights into different views on environmental ethics and might enrich understanding of how to solve the increasingly complex problems of the 21st century (Zidny & Eilks, 2018). According to the Special Report on Climate Change of the Intergovernmental Panel on Climate Change (n.d.), the United Nations body for assessing the science related to climate change, indigenous and local knowledge (ILK) is both a requirement and an entry strategy for participatory climate communication and action. The Congress of the Philippines initiates the recognition of ILK by establishing the Philippine Bamboo Industry Development Act – mandating the state to ensure the integration and continuous development of the Philippine bamboo industry through policies and programs that encourage the planting of bamboo, accelerate the development of bamboo-based products and designs (Congress of the Philippines, 2021). Bamboo, an indigenous and renewable resource, has been integral in the lives of Filipinos where for ages it has been utilised by localities for construction, furniture and handicraft manufacture, food, musical instruments, farm and fishing implements, pulp and paper, fuel for cooking and heating (Roxas, 2012). The country's land is conducive to its growth and propagation, making it readily and economically accessible. Its relevance to the built environment is out of the question. It is nowadays a sought-after resource because it does not release carbon dioxide into the atmosphere until the end life of the building (Manandhar, et al.,

2019). Lower energy is also required for its production compared to conventional construction materials. It is also a viable material for post-disaster recovery since it frequently grows in climates and regions susceptible to hurricanes, typhoons, floods and earthquakes, shelters can be constructed on the spot using locally available materials and labor (UN-Habitat, n.d.). Given the ecological and social benefits of bamboo, this paper reviews its suitability in mainstreaming climate creativity to economically challenged architecture students.

The Polytechnic University of the Philippines (PUP) is one of the country's government and highly competent education institution (Polytechnic University of the Philippines, n.d.). It is consistent about encouraging its students to explore solutions that tackle issues of both the environment and vulnerable communities. In 2017, PUP's Department of Architecture advanced its program by offering a specialization course on Bamboo Architecture and Research Design (BARD). It consists of three levels taken in three semesters. The first level, BARD 1, encompasses learning the fundamental principles and concepts surrounding bamboo. Understanding the meaning of its physiological and anatomical composition, its role and use in society as a transformative force through innovation and entrepreneurship, and its structural capacity and capabilities and its sustainability. While the second level, BARD 2, explains the various techniques employed when constructing with bamboo. Students are expected to learn the various bamboo technologies as applied in building construction, learn and identify the various tools and equipment that will aid in bamboo construction, analyze different bamboo research construction and developments and evaluate their application to the current situation, develop a unique bamboo construction and technology research and apply for its patent, and create a model output of the conducted research. In the final level, BARD 3, students are engaged in research undertaking that applies the learnings from previous BARD courses to come up with projects and products that can open doors for entrepreneurial opportunities.

Materials and Methods

The case of the Polytechnic University of the Philippines' architecture department is used in this study since this is the only architecture program in the country that offers a specialization course on bamboo. Participants of the study are students enrolled during the academic years 2021-2022 and 2022-2023. These students were selected for the study because they were handled by the same faculty during their project conceptualization stage. Sixteen students attended the course in the former year while there were nineteen enrollees in the latter year. The course was offered through distance learning, which carried on from the coronavirus (COVID-19) pandemic. Two methods were employed to assess the course's possible influence on students' perception of climate change. First is through project output which was done by group during the course period. Students were provided with the same instruction which is to select any issue in the built environment and then propose a solution through the application of bamboo. At the end of the course, a survey was disseminated to dive into students' perceptions of bamboo, especially if it will be recalled when climate change is the subject of discussion.

Results and Discussions

Project Output of Students from Academic Year 2021-2022

A group came up with the Bamboo Green Blocks (**Figure 1**) which utilized bamboo as reinforcements. The group's goal is to come up with an affordable way for low-income families to reconstruct their houses. Students also selected materials within the reach of these communities considering that these residents cannot afford to hire professional builders.

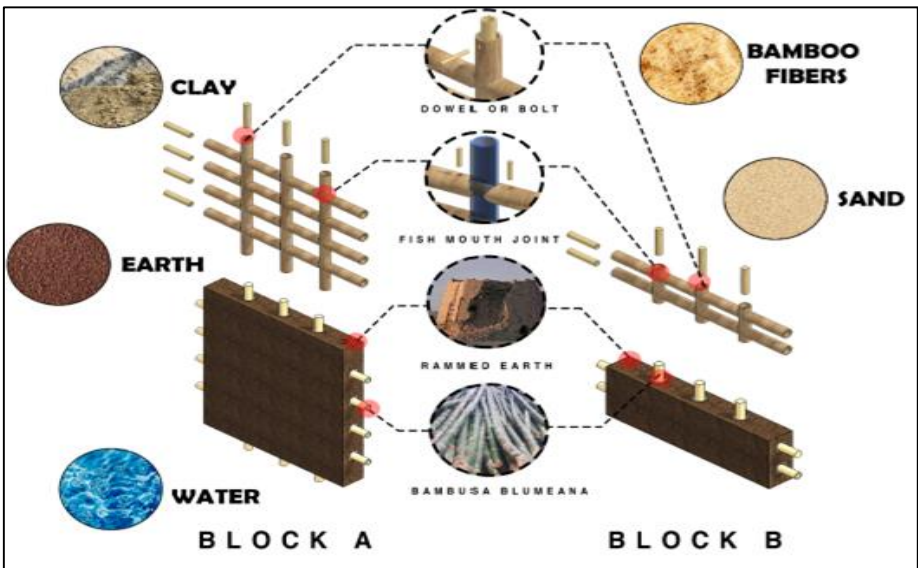


Figure 1. Bamboo Green Blocks by PUP BARD Students

Low-income houses have small floor areas due to budget constraints. This limits the amount of furniture that can be placed inside the house. One group addressed this by designing Bamboo Floor Cubes (**Figure 2**). The cubes can be removed to function as a chair or additional storage space. The lightweight cubes can be used to keep an emergency kit and carried in case a hazard occurs.

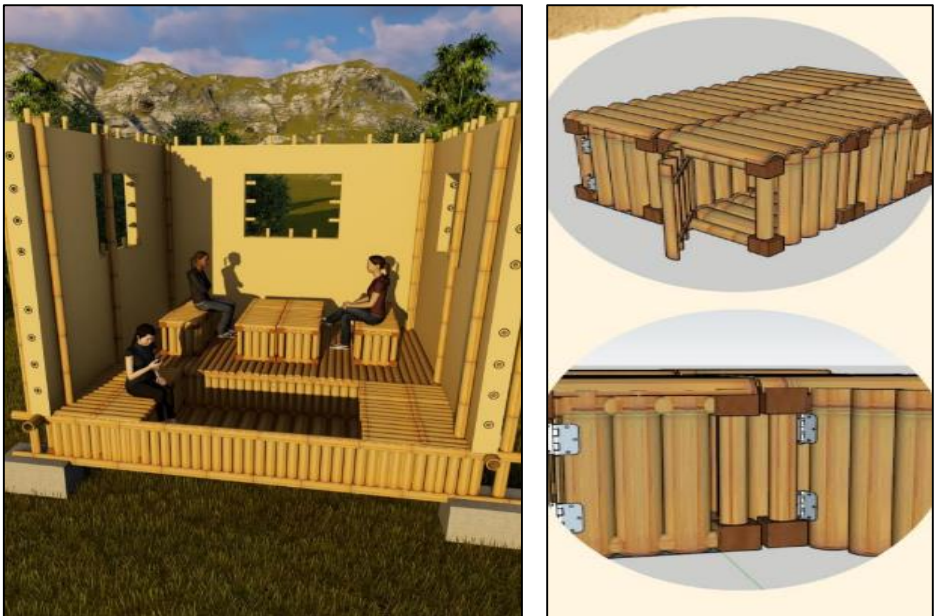


Figure 2. Bamboo Floor Cubes by PUP BARD Students

A structure with more openings typically has better airflow. This is not the case for homes located in warm and humid regions when more fenestrations could increase indoor heat. A group proposed the Sliding Bamboo Roof Panels (**Figure 3**) to allow warm air to escape upward. The proposed environmentally friendly and economical passive ventilation strategy also allows occupants to control the amount of air and daylight depending on their defined comfort.

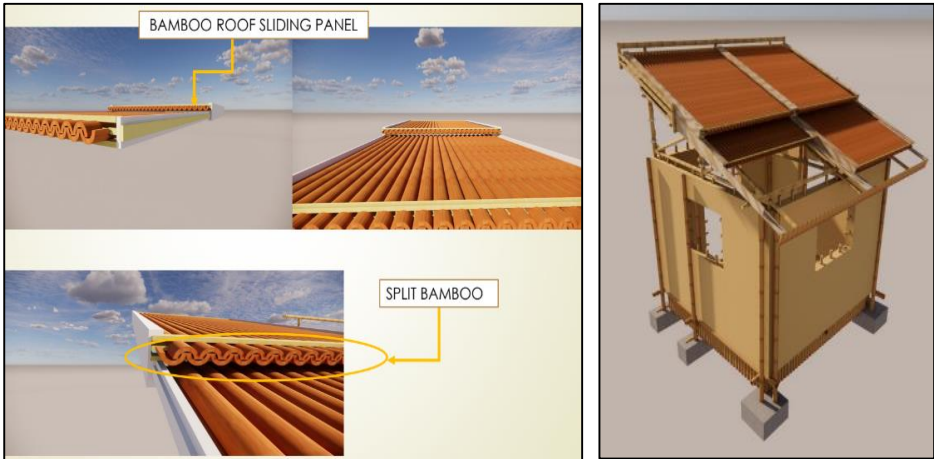


Figure 3. Sliding Bamboo Roof Panels by PUP BARD Students

Economical homes in the Philippines often disregard structural components essential for occupant safety, an example is the roof truss. The lack of this structural component leads to roofs being lifted away by the strong wind during typhoon season. Another group presented the Foldable Bamboo Roof Truss (Figure 4). It can also be reused and conveniently transported without the need to disassemble it.

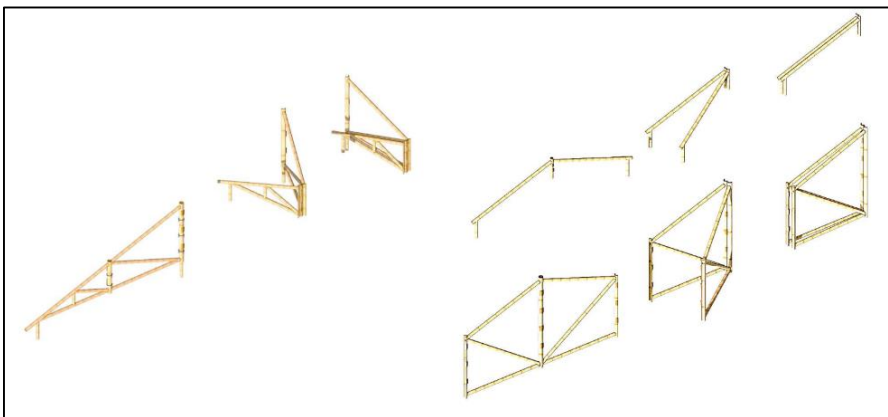


Figure 4. Foldable Bamboo Roof Truss by PUP BARD Students

Project Output of Students from Academic Year 2022-2023

During this period, pandemic restrictions have been completely lifted. This batch of students were able to meet face-to-face to create a prototype of their project.

Three groups of students from this batch designed panels to screen the sun's intense heat and light (**Figure. 5a, 5b, 5c**). Due to the following reasons: prolonged exposure to solar heat can cause heat stroke and dehydration while the presence of bright light can cause sun glare which affects our vision.



Figure 5a. Interlocking Bamboo Blocks by PUP BARD Students

Mechanism



- Use of nylon string to fasten the bamboo pieces together



Mechanism



- Use of 2 1/2" cabinet hinge for vertical bi-folding mechanism

Figure 5b. Bamboo Window Panel by PUP BARD Students



Figure 5c. Permeable Bamboo Wall Panel by PUP BARD Students

The fourth group proposed the Bamboo Insulator Panels (**Figure 6**) by combining bamboo culms with fibers (ex. bamboo; polyester). They looked into the possibility of decreasing energy consumption and the cost incurred from cooling one's house. On top of this, the students saw the importance of good acoustics in homes from studying virtually in the past years.

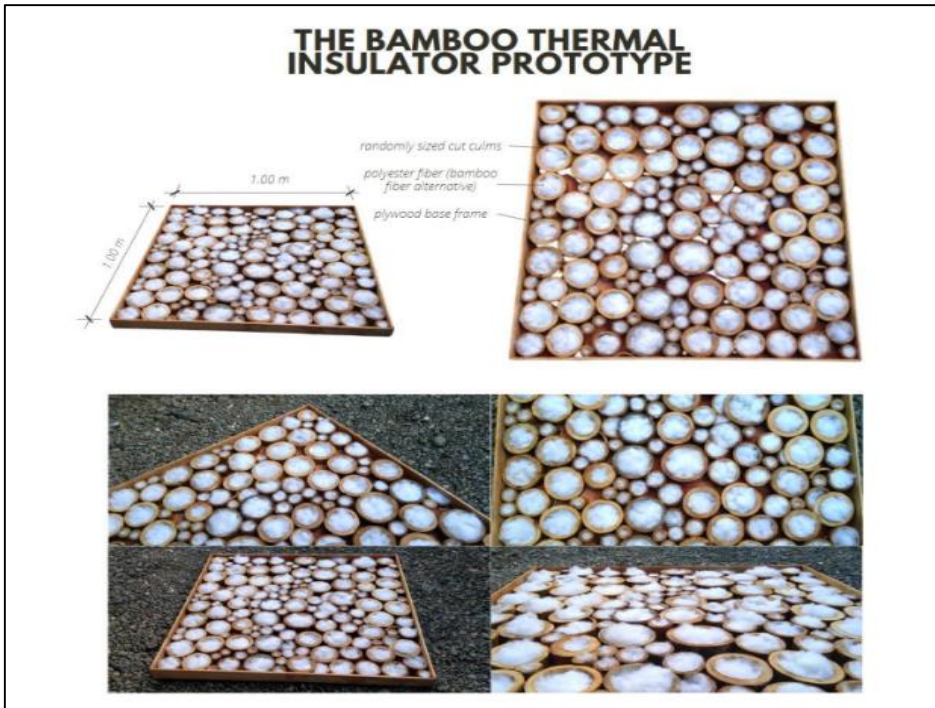


Figure 6. Bamboo Insulator Panels by PUP BARD Students

Students gave attention to spatial components that can be created even without technological advancements. Eco-friendly and economical materials were also considered for its other parts. However, their basis reflects a general and insufficient knowledge of the disproportionate risks of climate change. The variety of challenges brought by the differences in the local environment was also missed. Proposed designs adhere to concepts evident in vernacular structures, focusing on the indigenous ways of building with bamboo. The conservative design ideas reflect their intention of imparting knowledge to marginalized communities. Comparing the two batches of students, the batch who built a prototype was more conscious of the errors and improvements necessary to enhance the quality of their work. They saw the importance of having the right tools and equipment. These students also spoke about

being unsure of the effectiveness of their concepts as it was not tested in a controlled environment. Although the building activity provided students with more insights on how to approach their concepts, the one-time experience was insufficient as time should have been given for students to learn what would work.

Insights of Students

A survey questionnaire with open-ended questions was disseminated to the students through Google Forms. Students were asked if the specialization course is important for future architects. All respondents agreed that knowledge of bamboo is significant to architecture students for a wide variety of reasons. Based on the survey, some students merely see bamboo as an eco-friendly resource – "Although it has yet to be studied as a reliable building material for more complex and permanent structures, with further knowledge and research it can be the most eco-friendly material for building"; "It is one of the most renewable sources of construction material that is also native to the Philippines. It could lead to a more sustainable construction industry"; "Learning about bamboo can help decrease the use of timber in construction, reducing deforestation and its contribution to climate change"; "Exploring efficient ways of using bamboo can lessen greenhouse emissions which usually come from traditional building materials (such as steel and concrete)"; "Bamboo can address the lack of producing quality wood materials. Bamboo, on the other hand, grows faster compared to timber"; By continuing to study and maximizing bamboo in the field of construction, we can produce more environmental-friendly structures that can help in providing a more sustainable future.". The course focuses on coming up with bamboo products for entrepreneurial opportunities gave some students the thought that future architects' role is to advance its industrialization – "For me, Bamboo Industrialization is good as it may raise the level of bamboo to a higher level of competing with new variants of concrete and steel products. Breaking from its indigenous image may break the misconceptions of it being a material of no great

strength. Lastly, industrialization may also increase the options for other bamboo uses.”; “I think industrialization of bamboo is good but should be regulated. Industrialization of bamboo will encourage the market to use the material for construction thus popularizing it and creating more opportunities for the material. It will also encourage the community to have farms that will produce these specific bamboos and at the same time promote lesser use of wood. With the industrialization of bamboo, it will give more opportunity for forests and other protected areas to gradually recover from abrupt deforestation and climate change. But at the same time some might use this opportunity to gain more by increasing the price of bamboo to the market, which destroys the purpose of bamboo as a cost-efficient material for construction.”. There were responses that voiced about the course being an eye-opener for the youth – “There may be a lot of issues now regarding its use but what if the solutions are trapped inside the mind of a student without access to bamboo research? As young as we are now, I believe this incorporation of bamboo study as a subject is a big step towards its full promotion within the country.”; “In my point of view, bamboo is on its way to becoming the primary material for construction, and as early as now it is good to learn about it as we may unlock the other possibilities that would make it the best sustainable material for construction.”. Thus, one suggested for it “to be included in the curriculum of high school or even grade school to start so that everyone will be informed about its characteristics and uses as early as that stage.”. Though one hopes that the resource will become readily accessible to students, especially to those in cities – “The fact that it could grow anywhere is already a good thing because there won’t be a scarcity of materials. Probably the only con of using bamboo is the fact that it may not be directly available in the cities so it would have to be imported from the province. But it could be easily solved if there could be a place provided to grow certain bamboo species that can and will be used for construction.”.

Students were also asked, “What subject/s do you think is/are important for architecture students to understand and address climate change? and “How can future architects address climate change?”. Only three respondents stated that the bamboo specialization course is

important for future architects. For one student, architects should raise awareness of the benefits of bamboo for people to acknowledge its benefits – “I can contribute to climate action by promoting the use of bamboo in my designs. With this, designers and people can appreciate the beauty of using bamboo and its impact on the environment. Moreover, it can empower the architectural community to create a revolutionary movement that can solve this global problem”. The other two highlighted the need to consider the environmental implications of its building techniques – “Bamboo can be a very reliable building material for low-cost housing, but people should also consider the techniques and risks involved with it in order to make it an effective sustainable material, that if properly executed, the house could last up to 25 years.”; “It is also important that physical labor should be amplified and not be replaced by mechanical and technical labor. As much industrialization offers a big help to address the economic and social issues in our country, it has been proven throughout the years how advancement has always had negative repercussions on the environment, and that is what I think is the most critical yet overlooked.”. Most of the students selected the other courses offered by the department (i.e. Architecture Design, Tropical Design, and Planning). While the goal is to educate students about their environmental and social responsibilities, it is unsuccessful when they are unable to associate bamboo with climate action. Despite accomplishing the course where they worked on projects relevant to climate action, the concept remains vague to some students – “Building first my foundation in understanding the environmental, societal, and economic implications of climate change; “By keeping up to date with the issues and supporting initiatives.”; “Understanding more about how people contribute to climate change, explore sustainable strategies and ways.”. Responses, such as: “It is important to create spaces that will allow people to actively take part in saving the environment”; “I may not contribute to any grand gestures, but I will ensure that as long as I can my architecture will mitigate the negative effects of climate change”; “By designing architecture that will have long-term benefits for both the

communities and environment,”), reflect that students have an overview of their role but are unsure of the realistic ways they can tackle the climate crisis.

Conclusion and Recommendations

With the effect and challenges of climate change on the built environment, pedagogy in architectural education is critical for future built environment practitioners to understand the implications of their chosen profession. Education has the potential to increase young people’s capacity to adapt to the harsh impacts of climate change by building important knowledge and a breadth of “green skills” (Brookings Institution, 2021). Redirecting education efforts to build ‘green skills’ appears to be a clever way to ensure that investment achieves a double impact both on education and on climate, but it is deeply unrealistic given the reality of education in poor countries (Smith, 2021). For instance, education institutions in lower middle-income countries, such as the Philippines, still face considerable differences in resources. Philippine State Universities and Colleges operate depending on the budget allocated by the national government (Republic of the Philippines House of Congress, n.d.). Resource allocation is essential in the production of research and innovation while on the other hand, there is a need to consider the socioeconomic background of students. Students’ creativity is contingent on a learner’s acquired skills which can be profoundly affected when the school and an individual’s resources are scarce. This study underscores connecting students’ creativity to indigenous knowledge (ILK) to open economically challenged students to the response options that they can adopt to address real-world issues.

The Polytechnic University of the Philippines’ Department of Architecture offers two specialization courses. In addition to Bamboo Architecture Research and Design, students may also take Construction Management. The bamboo specialization course is an avenue for students to see another path of climate action, which is ameliorating the knowledge of climate-vulnerable communities. However, designing a curriculum that concludes with ideas for entrepreneurial opportunities

may limit students' creative exploration. Students will tend to only associate bamboo with creating products when it can also be used to build structures. In addition, the lack of resources such as tools, equipment, and access to bamboo could discourage students from acknowledging its value. Students will not be able to grasp the point of learning it when ideas are stuck as concepts on paper and when they are still unable to successfully utilize bamboo even after studying it. Moreover, students need to become confident that they can apply their learnings in real-life situations and that there are opportunities beyond the classroom setting. According to the former chairperson of the department, it is found that students prefer to enroll in the construction management specialization course because they think it is more practical as it can be applied to employment.

Bamboo even today is an unconventional building material. Therefore, selecting faculties who are experienced with bamboo is crucial in the execution of such program. The academia can be an avenue to increase the knowledge and promote its use to co-professionals. Cultivating a bamboo culture within the school environment will motivate students to learn and excel. The participation of indigenous communities would be consequential in developing this culture. Community involvement makes it possible to pursue more ambitious goals, with the preservation of culture and the empowerment of indigenous peoples as one of the main focuses for the promotion of an intercultural curriculum (da Silva, Fátima Pereira, et al., 2023). Informing students about the indigenous ways of applying the resource from the communities themselves can prevent the replication of ideas. Furthermore, understanding the real-life indigenous way of applying bamboo can help students see its successes and failures, since these communities are most likely climate vulnerable. This will allow students to assess the relevance of their proposed approach and hence what innovations should be introduced. Indigenous individuals may also be present within the school community, suggesting that they be involved in the enhancement of teaching and formulation of the curricula. Research has shown that reinforcing Indigenous students' cultural

identities at school improves their performance overall (Harrison, 2022). Students need to feel connected culturally to become connected to school educationally (Harrison, 2022). With this, students may acknowledge the social value of bamboo which will help them comprehend their role in advancing this indigenous resource. When students are aware that there are communities that highly depend on it especially when these communities exist among them, they may be encouraged to advocate its utilization when they graduate.

To conclude, the role of economically challenged students in addressing the climate crisis should not be disregarded. These individuals are vital to solving this global problem as they can represent and relate to the vulnerability of marginalized communities. The problem is that the lack of resources limits their participation. Bamboo is a resource that commonly grows and is economically accessible in lower middle-income countries that are climate-vulnerable and at the same time continue to face education challenges. Therefore, bamboo should be explored and used as a means to transform students into agents of change. Reviewing these opportunities can aid in determining the specific objectives and outcomes critical to capacity development that will prepare the students to solve real-life problems. Students are to realize that climate action is about complementing ecological approaches with social responsibilities.

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