Chapter in Book

From Concept to Creation: The Intersection of Sustainability and STEM in a City Diorama

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Abstract: *As the world's population grows and urbanization continues to rise, creating sustainable cities becomes increasingly important. In this paper, we present a sustainable city diorama built using STEM education as a means to inspire the next generation of urban planners, architects, engineers, and scientists to develop innovative solutions to sustainability challenges. The problem statement is clear: the traditional model of urban development is unsustainable, resulting in issues such as pollution, resource depletion, and climate change. We aim to address this problem by demonstrating how STEM education can be used to create a sustainable city model. The solution is the sustainable city diorama, which showcases sustainable practices and technologies such as green roofs, renewable energy sources, and efficient transportation systems. The diorama was built using a multidisciplinary approach that incorporated principles of architecture, engineering, and environmental science. The impacts of the project are significant. By exposing students and educators to sustainable practices and technologies, we hope to inspire the next generation of leaders to prioritize sustainability in their careers and personal lives. The diorama also has potential as an educational tool for community outreach programs, museums, and other public spaces. Finally, the commercialization potential of the project is worth considering. The sustainable city diorama could be replicated and sold to educational institutions and community organizations as a teaching tool. The project could also be expanded to include more sustainable technologies and practices, opening up opportunities for research and development partnerships. In conclusion, the intersection of sustainability and STEM education is crucial in developing sustainable cities. The sustainable city diorama is an innovative and effective tool for inspiring and educating future leaders in sustainability.*

Keywords: sustainable city; STEM; diorama.

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1. INTRODUCTION

In today's rapidly growing and urbanizing world, creating sustainable cities has become a critical priority. The traditional model of urban development, which prioritizes economic growth over environmental concerns, has resulted in a host of sustainability challenges, including pollution, resource depletion, and climate change. As we strive to address these challenges, it is becoming

increasingly clear that we need innovative and interdisciplinary approaches that incorporate principles of science, technology, engineering, and math (STEM) with sustainability. According to the Intergovernmental Panel on Climate Change (IPCC), urban areas are responsible for 70% of global greenhouse gas emissions, and are highly vulnerable to the impacts of climate change (IPCC, 2018). As a result, there is an urgent need to transition to more sustainable and resilient urban systems. STEM education can play a critical role in this transition, by equipping future generations with the skills and knowledge needed to develop and implement innovative sustainable solutions.

In recent years, there has been a growing recognition of the need to incorporate sustainability principles into STEM education. For example, a study by Matzen et al. (2019) found that integrating sustainability into STEM education can lead to improved student engagement, motivation, and learning outcomes. Similarly, a study by Figueiredo et al. (2017) found that incorporating sustainability into engineering education can lead to more sustainable engineering practices. In this paper, we present a sustainable city diorama that embodies this intersection of sustainability and STEM. The diorama serves as a physical representation of how STEM education can be used to create sustainable cities, and as a teaching tool for inspiring the next generation of leaders to prioritize sustainability in their careers and personal lives. We explore the process of taking this diorama from concept to creation, highlighting the various STEM principles and sustainability practices incorporated along the way.

The sustainable city diorama is more than just a model; it is a symbol of hope and possibility. It represents a future where sustainable urban development is not just a goal, but a reality. We hope that this paper will inspire others to explore the intersection of sustainability and STEM in their own work, and to work together to create a more sustainable world.

2. METHOD & MATERIAL

To create the sustainable city diorama, we employed a variety of STEM principles and sustainability practices. The diorama was built on a base of recycled materials, including cardboard, stones, sticks, sand and papers, which were chosen for their low environmental impact and ease of use. We also incorporated renewable energy sources into the diorama, including solar panels and wind turbines, to demonstrate the potential for clean energy in urban environments.

In addition to the physical materials used, we utilized a variety of digital tools and software to design and model the diorama. This included using CAD software to create 3D models of the cityscape, and simulation tools to test the impact of different sustainability interventions on energy use and environmental performance. Here, mathematics knowledge in drawing plans and their elevation from different angles were applied in the creating and designing process. This is because we need to know the size of the building cars, height of hills and model humans, length of rivers, so on and so forth using the knowledge about ratio. All of this knowledge which we learnt in mathematics subject were fully utilized and applied in building the sustainable city diorama.

To ensure that the diorama accurately represented real-world sustainability practices and principles, we conducted extensive research into the latest trends and technologies in sustainable urban development. This included reviewing scientific literature on topics such as green infrastructure, renewable energy, and sustainable transportation (Jiang et al., 2018; Khan et al., 2020; Mladenovic et al., 2017). Besides doing research online, we also did some literature reviews in the school library and the Sandakan District Library to ensure we did not miss any latest and previous information regarding the progression and expansion of renewable energy and how STEM could be used in the sustainability of a city globally.

We also consulted with experts in the field of sustainable urban development, including architects, engineers, and urban planners, to gain insights into best practices and emerging trends. We interviewed some of the experts in this field so that we would have a better understanding about the current strategies used in increasing the sustainable city both locally and globally. This allowed us to ensure that the diorama was not only aesthetically pleasing, but also reflected the latest research and thinking in the field of sustainable urban development.

Overall, the sustainable city diorama was created through a collaborative and interdisciplinary approach, incorporating principles of STEM and sustainability at every stage of the design and construction process.

3. FINDINGS

By completing our project, we identified a few findings which we categorized them into a few themes. They are as follow:

3.1 Benefits of Sustainable Urban Development

The sustainable city diorama we created demonstrates the potential for STEM education to be used as a tool for promoting sustainable urban development. By incorporating renewable energy sources, green infrastructure, and sustainable transportation systems into the diorama, we were able to showcase the benefits of sustainable urban development in a visually engaging way. These benefits include enhancing the resilience of cities to climate change and other environmental challenges, improving the quality of life and well-being of urban residents, and reducing the negative environmental impacts of urbanization.

3.2 Importance of Integrated Approaches

Our research into the latest trends and technologies in sustainable urban development highlighted the importance of integrated approaches to urban sustainability. This includes incorporating multiple sustainability interventions into urban design, and using digital tools and simulation models to test and optimize the performance of these interventions. By taking an integrated approach, we can more effectively address the complex and interconnected challenges facing cities today.

3.3 Challenges and Barriers to Sustainable Urban Development

Through our research and collaboration with experts in the field, we were also able to identify several key challenges and barriers to achieving sustainable urban development. These include issues such as political will, funding constraints, and lack of public awareness and engagement. However, we believe that by highlighting the potential benefits of sustainable urban development through projects such as the sustainable city diorama, we can help to build momentum towards more sustainable and resilient urban futures.

3.4 Commercialization Potential

Finally, the commercialization potential of the sustainable city diorama is significant. As cities around the world increasingly prioritize sustainability and resilience in their urban planning and design, there is a growing demand for educational tools and resources that can help to build public awareness and engagement around these issues. The sustainable city diorama could be used as an

educational tool in schools, museums, and other public spaces, helping to promote STEM education and sustainability principles to a wider audience. There is also potential for collaboration with private sector partners to develop and distribute the diorama on a larger scale, opening up new commercial opportunities.

Overall, the sustainable city diorama represents a successful intersection of STEM education and sustainability principles, demonstrating the potential for interdisciplinary collaboration to create more sustainable and resilient urban environments.

4. DISCUSSION

Our study examines the intersection of sustainability and STEM education in a city diorama, a physical model that simulates an urban environment. We found that the diorama can serve as a useful tool for engaging students and the wider community in sustainability education, allowing them to better understand the complex interactions between natural and built systems, and to explore different strategies for promoting sustainable urban development. Our analysis reveals several key themes that emerged from our study.

Firstly, the diorama can facilitate interdisciplinary learning, bringing together concepts from different STEM fields. This can help students to develop a more comprehensive understanding of urban sustainability issues, and to appreciate the diverse range of approaches and solutions that are available. This finding is in line with Lelliott and Cavan (2019) and Wang, Ma and Qiu (2018). For example, students can learn about the engineering principles behind sustainable building design, the mathematics knowledge of drawing plan and elevation, and ratio when determining the size of each object in the diorama, the scientific knowledge of renewable energy and how they work, and the latest technologies that influence sustainability outcomes.

Secondly, the diorama can foster creativity and innovation among students (Bursztein & Pringle, 2016). By allowing students to design and build their own mini-cities, the diorama provides a platform for experimenting with new ideas and approaches, and for developing innovative solutions to sustainability challenges. For example, students can explore different materials and technologies that can be used to create more sustainable buildings, or develop new strategies for promoting active transportation and reducing carbon emissions.

Finally, our research also indicates the commercialization potential of the diorama as a tool for engaging wider public audiences in sustainable urban development. The diorama can serve as a powerful communication tool, allowing complex sustainability concepts to be conveyed in a clear and accessible way, and helping to build support for sustainable policies and practices. For example, the diorama could be used to engage urban planners and policymakers in discussions about sustainable urban design, or to educate the public about the benefits of sustainable transportation options.

5. CONCLUSION

In conclusion, the city diorama has the potential to play a key role in building the next generation of sustainability leaders and innovators, and in promoting more sustainable and resilient urban environments. While there is still much work to be done to ensure our urban environments are truly sustainable and resilient, the diorama can serve as a powerful tool for integrating sustainability and STEM education, fostering creativity and innovation, and engaging the wider public in sustainable

urban development. Our study adds to the growing body of literature on the potential of the diorama as a tool for sustainability education and highlights the importance of this interdisciplinary approach in building a sustainable future.

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