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Preface

Pioneering Educational Perspectives: Series 2025 is a collection of thought-provoking insights and research contributions exploring contemporary educational trends and practices. This eBook presents a diverse range of perspectives on innovative teaching methodologies, digital learning strategies, and transformative approaches in education. Designed to serve as a resource for educators, researchers, and practitioners, it aims to inspire meaningful discussions and advancements in the field. Through carefully curated chapters, this publication offers fresh ideas and practical solutions to enhance learning experiences in an ever-evolving educational landscape.

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IOT-3D SYNERGY: COLLABORATIVE, INNOVATIVE AND CONTEXTUAL PROJECT-BASED ASSESSMENT FOR FUTURE STEM TEACHERS

Muhamad Furkan Mat Salleh^{1*}, Nurul Akmal Md Nasir², Nurhayani Romeo³, Norezan Ibrahim⁴ & Mohamad Hisyam Ismail⁵

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ABSTRACT

The IoT-3D Synergy: Collaborative, Innovative, and Contextual Project-Based Assessment for Future STEM Teachers (IoT-3D CIC) is an innovative educational tool designed to enhance STEM learning among pre-service teachers. Integrating the Internet of Things (IoT) and 3D printing within a project-based framework, this assessment allows students to design and implement functional models equipped with IoT components, such as sensors and microcontrollers, while also creating 3D-printed structures. Over three semesters, the project has been successfully implemented, involving over 400 students in diverse projects like green cities, aquaculture, and agriculture. By adhering to the Integrated STEM Education framework and situated cognition theory, IoT-3D CIC promotes hands-on learning, fosters creativity, and develops essential 21st-century skills. The innovation not only enhances technical competencies but also encourages critical thinking and collaboration, preparing future educators for the challenges of modern STEM education. This initiative demonstrates significant potential for scalability and adaptation across various educational settings, supporting the global need for innovative and contextual STEM teaching methodologies.

KEYWORDS: Internet of Things, 3D Printing, Integrated STEM, Pre-Service Teachers, Project-Based Assessment.

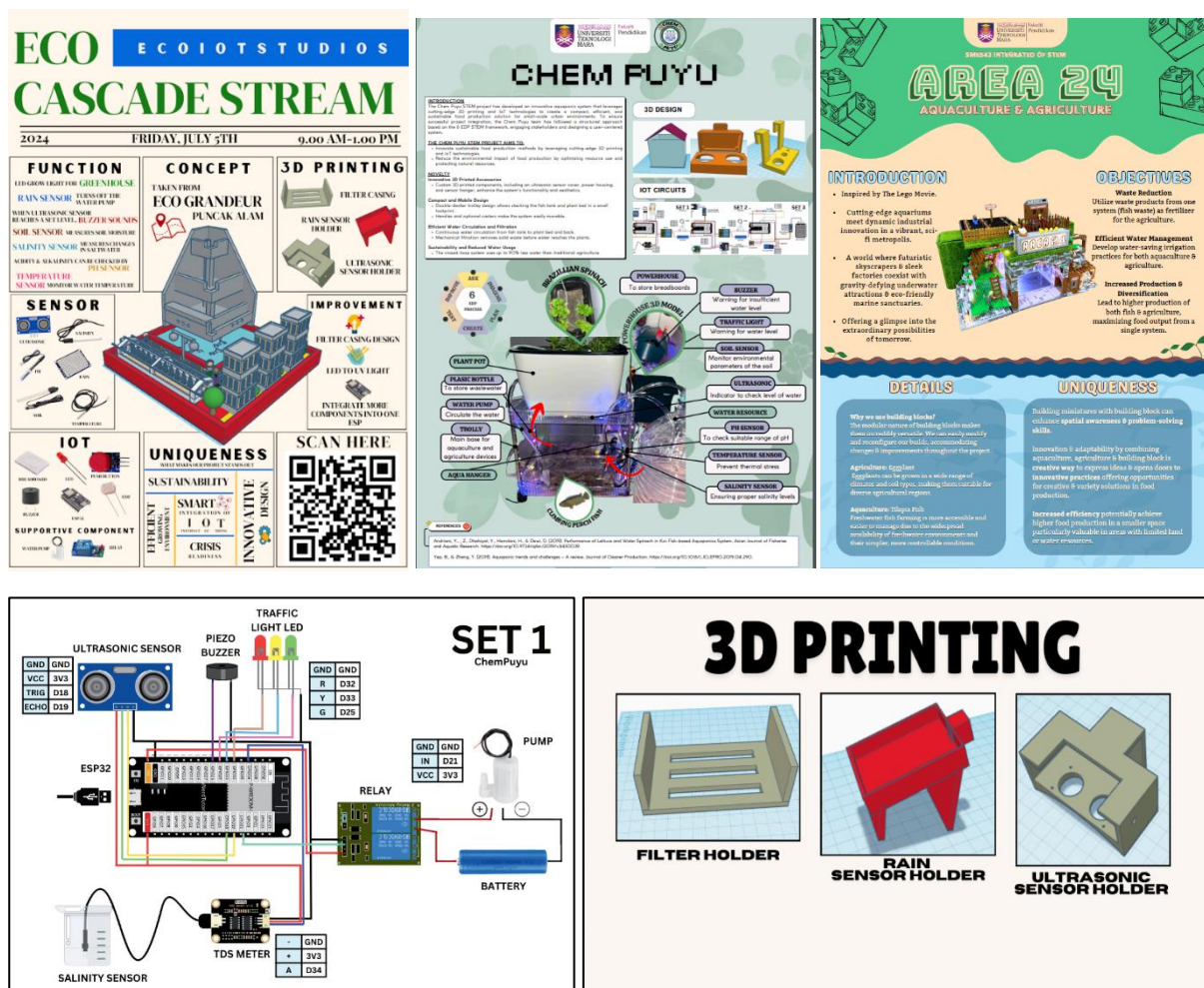
PROBLEM AND OBJECTIVE

The primary problem addressed by the IoT-3D CIC initiative is the gap between traditional teaching methods and the technological competencies required for modern STEM education. Many pre-service teachers lack exposure to practical, technology-based learning experiences, which limits their ability to effectively integrate these tools into their future classrooms (Mishra & Koehler, 2006). This gap has been increasingly evident as educational technologies continue to evolve rapidly, demanding a more hands-on and contextual learning approach (Almazroui, 2023). The objective of this project is to bridge this gap by providing a contextual, hands-on learning experience that combines IoT and 3D printing, fostering the development of critical 21st-century skills such as creativity, collaboration, and problem-solving. This is particularly important as these skills are crucial for preparing future teachers to handle the technological demands of contemporary educational settings and to foster a more engaging learning environment.

DESIGN DESCRIPTION

The IoT-3D CIC project is designed as a collaborative, project-based assessment framework that integrates IoT and 3D printing technologies. Its purpose is to enhance the teaching and learning of STEM among pre-service teachers by engaging them in real-world projects that require the application of IoT components, like sensors and microcontrollers, and 3D-printed models. Students are tasked with designing and building mini-models on themes such as green cities, aquaculture, and agriculture, using tools like Tinkercad for 3D design and Blynk for IoT monitoring. This comprehensive approach enables students to gain practical experience in both IoT and 3D printing, preparing them for future educational environments that increasingly rely on digital tools and technologies. Moreover, this framework encourages an iterative learning process, where students apply theoretical knowledge to real-world scenarios, test their designs, and refine them based on feedback and testing outcomes, ultimately promoting a deeper understanding of STEM concepts.

VISUALS



NOVELTY AND UNIQUENESS

The novelty of IoT-3D CIC lies in its unique combination of IoT and 3D printing within a project-based learning framework. Unlike traditional STEM education methods, this initiative provides a fully integrated approach that combines theoretical knowledge with practical application. It challenges students to think creatively and work collaboratively, promoting a deeper understanding of STEM concepts through hands-on, contextual learning experiences. The dual integration of these technologies offers a platform where students not only learn about

IoT and 3D printing but also apply these tools to solve real-world problems, thereby enhancing their technical skills and innovation capabilities. This method stands out from conventional approaches by fostering an engaging, experiential learning environment that better prepares pre-service teachers for the realities of a technology-driven classroom.

BENEFITS TO MANKIND

The IoT-3D CIC project provides numerous benefits, including enhancing STEM education by integrating modern technologies and fostering essential skills such as critical thinking, creativity, and collaboration. This initiative not only prepares pre-service teachers for the challenges of the 21st-century classroom but also equips them to inspire and educate the next generation of students in an increasingly digital world. Additionally, by promoting a project-based learning approach, the IoT-3D CIC helps students develop problem-solving skills and adaptability, which are crucial for navigating complex, real-world scenarios. These benefits contribute to the broader goal of producing well-rounded educators who are capable of leading innovative and effective STEM education initiatives.

COMMERCIAL POTENTIAL

The IoT-3D CIC framework has significant market potential due to the growing demand for innovative educational tools that integrate technology and real-world application. Its scalable design allows for adaptation in various educational contexts, both locally and globally. By offering training and licensing opportunities, this framework can be commercially viable, providing educational institutions with a valuable resource for enhancing STEM programs. As more schools and universities recognize the need for technology-integrated curricula, the IoT-3D CIC stands out for its comprehensive, hands-on approach, offering a competitive advantage in the education technology market. The potential for wide-scale adoption and customization further underscores its commercial appeal.

CONCLUSION

The IoT-3D CIC represents a transformative approach to STEM education, combining IoT and 3D printing to create a comprehensive, hands-on learning experience for pre-service teachers. This initiative not only fills a critical gap in STEM education but also offers significant potential for future growth and adaptation. Moving forward, we aim to expand the project to include more diverse themes and explore its application in different educational settings, further enhancing its impact on future STEM educators. By continuing to innovate and adapt, the IoT-3D CIC will remain at the forefront of educational advancements, preparing educators and students alike for the evolving demands of the 21st century.

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