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Chief Editors:
Nur Alyani binti Khairol Anuar
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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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IMMERSIVE IOT LEARNING WITH AR-MICROC: A NEW EDUCATIONAL PARADIGM

Farah Waheda Othman[1]*, Irdayanti Mat Nashir [2], Mohamad Syahril Mat Saad[3], Ramlee Mustapha[4] & Mohamed Nor Azhari Azman[5]

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ABSTRACT

The introduction of AR-MicroC establishes a new educational paradigm by integrating Augmented Reality (AR) into IoT learning, specifically focusing on microcontroller systems like Raspberry Pi and Arduino. This immersive platform revolutionizes the learning experience by offering students interactive, visually rich environments that enhance comprehension. Through dynamic animations, interactive 3D visualizations, and virtual objects, students gain an in-depth understanding of electronic components and circuits, transcending traditional teaching methods. By engaging learners in active exploration, AR-MicroC promotes knowledge retention and fosters practical application of complex concepts. This innovative tool bridges the gap between theoretical and hands-on learning, allowing students to interact with virtual representations of circuits in real-time. It addresses the growing demand for skilled professionals in electronics by equipping students with both knowledge and confidence for real-world applications. As the digital era advances, AR- MicroC positions itself as a key driver in transforming IoT education, providing an engaging, effective, and forward-thinking approach to preparing learners for future technological challenges.

KEYWORDS: Augmented Reality, Internet of Things, Microcontrollers, Immersive Learning, Educational Technology

PROBLEM AND OBJECTIVE

The rise of digital technologies has transformed the educational landscape, offering innovative methods to enhance learning experiences. Among these advancements, Augmented Reality (AR) stands out for its ability to create immersive, interactive environments that deeply engage students. This paper presents AR-MicroC, a specialized learning module designed for the Internet of Things (IoT) course, aiming to provide a dynamic and impactful educational experience. AR-MicroC focuses on teaching microcontrollers for Raspberry Pi and Arduino, which are essential components in the IoT ecosystem.

Despite AR's potential to revolutionize education, there is a notable lack of empirical research evaluating its effectiveness in real-world settings, especially in technical courses like IoT. The concept of microcontrollers, which requires strong visualization skills, often poses challenges for students (Liono et al., 2021). Information Technology students, particularly those without a background in electricity or electronics, may find it difficult to grasp the concepts and devices used in IoT. This is because IoT education demands knowledge in areas such as electrical circuits, sensors, communication systems, analog and digital electronics, microprocessors, and programming (Barak, 2017). This knowledge gap also creates challenges for educators in delivering effective lessons.

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A study by Techanamurthy et al. (2020) on IoT instruction at Community Colleges revealed that traditional, instructor-centered methods such as lectures and demonstrations using PowerPoint presentations and online resources often fail to engage students or fully convey complex concepts. This lack of engagement can hinder students' comprehension and motivation, leading to lower academic performance.

This study assesses the effectiveness of the AR-MicroC module in improving the achievement and motivation of students enrolled in the Information Technology Certificate program at Malaysian Community Colleges. Using a quasi-experimental design and the m-ADDIE model, the research provides empirical evidence on the educational benefits of integrating AR into IoT instruction. The results show that AR-MicroC significantly enhances student learning outcomes and motivation, demonstrating its potential as a transformative tool in modern educational practices.

DESIGN DESCRIPTION

The development process for this learning application is based on the five phases of the m-ADDIE Model. The m-ADDIE model is an instructional design model that has been improved and modified from the original ADDIE model (Ahmad Zamzuri et al., 2012). This model can be used effectively as a guideline for the development of new educational software based on multimedia (Ahmad Zamzuri, 2019). m-ADDIE is an acronym in 5 phases namely Analyze, Design, Development, Implementation and Evaluation and 'm' is dedicated to the development of multimedia educational software.

VISUALS

The AR-MicroC innovation product was developed as the main module in learning Introduction to the Internet of Things. The module is developed as a physical module through the publication of a book titled "Modul Mikropengawal AR-MicroC" and an AR-MicroC mobile application that uses Augmented Reality technology.



Figure 1: AR-MicroC module and application

NOVELTY AND UNIQUENESS

Immersive Learning Environment: Unlike traditional learning tools, AR-MicroC leverages AR to create an interactive, 3D environment where students can visualize and manipulate virtual representations of microcontroller components, circuits, and IoT systems. This hands-on experience deepens understanding and makes abstract concepts more tangible.

Focus on Microcontrollers for IoT: While many AR tools exist for general electronics education, AR-MicroC is specifically tailored to teach microcontrollers (Raspberry Pi and Arduino) within the IoT domain. This targeted focus addresses a growing need for expertise in a critical area of technology, giving the platform a niche advantage.

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Bridging the Theory-Practice Gap: AR-MicroC offers a unique solution by integrating theoretical knowledge with practical, real-time visualization. This makes it easier for students, especially those without an electronics background, to grasp complex IoT concepts by virtually interacting with components they would otherwise struggle to understand in traditional, lecture-based environments.
Active Engagement and Motivation: The module goes beyond passive learning by actively engaging students through interactive exercises. The immersive AR experience boosts student motivation, making learning enjoyable and fostering deeper retention compared to conventional lecture-based methods.
Empirical Research-Driven Design: The product's design is grounded in educational research, using a quasi-experimental approach and the m-ADDIE model to measure its effectiveness in improving academic performance and student motivation. This empirical foundation sets AR-MicroC apart as a data-driven innovation in education.

BENEFITS TO MANKIND

The AR-MicroC platform offers numerous benefits to mankind by revolutionizing IoT education. It enhances learning through immersive, interactive experiences, making complex concepts like microcontrollers more accessible. By bridging the skills gap, it prepares students for careers in the rapidly advancing tech industry. Additionally, AR-MicroC democratizes education, providing opportunities for underprivileged communities to gain valuable knowledge and skills. It fosters innovation, empowering learners to develop creative solutions for real-world challenges, while promoting sustainable, resource-efficient educational practices for a better future.

COMMERCIAL POTENTIAL

The AR-MicroC (CRLY2024W00222) has been registered under the Intellectual Property Corporation of Malaysia (MyIPO), securing its intellectual assets and ensuring a competitive market advantage. It has also been published on the Google Play Store, providing global accessibility for educators, students, and tech enthusiasts. As one of the largest app distribution platforms, Google Play enhances the product’s discoverability and encourages widespread adoption. With its focus on the rapidly growing IoT and EdTech markets, AR-MicroC offers strong commercial potential through educational institutions, vocational training, and industry partnerships.

CONCLUSION

AR-MicroC stands out for its innovative use of Augmented Reality to enhance IoT education by offering an immersive, interactive learning experience. It addresses the need for practical, hands- on understanding of microcontrollers and IoT systems, making complex concepts more accessible and engaging. Future directions for AR-MicroC could include expanding content to cover more IoT applications and advanced electronics topics, integrating AI-driven personalized learning paths, and developing partnerships with industry leaders for customized training solutions. Enhancing cross-platform compatibility and exploring VR integration could further elevate the learning experience and broaden its market appeal.

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