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# Revolutionizing Electrical Learning: An Interactive App for More Effective Teaching

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## Abstract:

*Revolutionizing Electrical Learning: An Interactive App for More Effective Teaching* Project transforms complex electrical engineering education into an engaging knowledge-based experience. The project is built on the premise that students can learn better if given a user-friendly toolkit that demystifies and encourages practical experimentation with notoriously complex electrical concepts, which almost every student has difficulty with. This program combines the M-ADDIE model with the iterative and collaborative nature of SAM or Agile to nurture creativity and confidence within participants when it comes to designing circuits. The provided toolkit includes modular components and allows learners to follow step-centered instructions to build and test multiple circuits with varying complexity. This ensures that both novices and people who are advanced in the subject matter can have unrestricted access to enhancing their knowledge. The purpose of the project is to determine its effectiveness in an actual scenario, which was possible due to the design thinking approach taken. Early tests indicate significantly advanced outcomes regarding the learner's understanding and retention of electrical concepts. Feedback certainly did highlight raised levels of engagement and motivation as well as deeper learning. The project also fosters increased collaboration from students, as there is a hands-on approach that requires students to work as a unit to tackle problems and devise inventive solutions. This fosters teamwork, which is a crucial skill in the real world. Instead of working around the problems posed by electrical engineering education, this project also motivates change, which makes the whole learning experience even more interactive, which enhances its effectiveness. This will set the foundation for future education.

**Keywords:** M-Addie, User-friendly, Interactive, Design Thinking, Digital Electronics.

## Introduction

This product delivers a proprietary approach to hands-on learning for circuit creation and troubleshooting that incorporates micro-credentials to validate skills. Virtual and remote laboratories have shown potential to complement or even replace physical labs, especially in improving learning outcomes and accessibility (Brinson, 2015). Furthermore, the integration of design thinking fosters innovation and student-centered problem-solving in technical education (Henriksen, Richardson, & Mehta, 2021). This platform allows users, mostly students and hobbyists, to design, simulate, and execute electronic circuits in an intuitive digital workplace. Through the integration of various learning modules and practical tools, users can enhance their theory and practical skills in electronics and engineering.


Figure 1: Front Page of the product images

The objective of this *Revolutionizing Electrical Learning: An Interactive App for More Effective Teaching* innovation is:

1. Enhance Conceptual Understanding – Enable learners to grasp complex electrical engineering concepts through a hands-on, knowledge-based approach.
2. Develop Practical Circuit Design Skills – Provide students with a modular toolkit that facilitates step-by-step experimentation with electrical circuits of varying complexity.
3. Improve Learning Retention and Engagement – Utilize design thinking principles to ensure deeper understanding and higher motivation in learning electrical engineering.
4. Support Learners of All Levels – Ensure that both beginners and advanced learners benefit from an accessible, adaptable learning experience.

The scope of the *Revolutionizing Electrical Learning: An Interactive App for More Effective Teaching* project encompasses several key areas to ensure its effectiveness in enhancing electrical education.

1. Target Users – This project is designed for students, educators, and enthusiasts in the field of electrical engineering and electronics. It caters to secondary and tertiary students, particularly those in polytechnics, technical institutions, and vocational training programs. Additionally, hobbyists and self-learners interested in circuit design and troubleshooting can benefit from the platform.
2. Content and Learning Modules – The innovation includes structured learning modules that cover fundamental to advanced electrical concepts. It provides interactive lessons, hands-on activities, and step-by-step circuit design tutorials. The modules integrate both theoretical explanations and practical applications to ensure a comprehensive learning experience.
3. Technological Features – The platform utilizes a user-friendly digital interface, incorporating real-time circuit simulation tools. It includes a modular toolkit that allows users to build, test, and modify circuits virtually. Additional features such as gamification, real-time feedback, and collaborative learning spaces enhance the overall learning experience.
4. Implementation in Educational Institutions – This project is designed to complement traditional teaching methods by integrating into electrical and electronics curricula. It can be used as a classroom tool for instructors to demonstrate circuit principles, as a lab alternative for students with limited access to physical components, and as a self-learning platform for independent study.
5. Assessment and Certification – To validate students' progress and competencies, the project includes an assessment framework that offers quizzes, skill-based tasks, and practical circuit-building challenges. Upon successful completion, students can earn micro-credentials or digital badges, which can be used as proof of competency in circuit design.
6. Scalability and Expansion – The project is designed to be scalable, allowing for future expansion with additional modules, updated content, and integration with emerging technologies such as IoT and AI in electrical applications. Future versions may include mobile app development, multilingual support, and integration with existing Learning Management Systems (LMS).

By defining these key areas, the project ensures a well-structured, accessible, and engaging approach to electrical learning, providing a valuable tool for students, educators, and lifelong learners.

## Research Methodology

This product is built on a new concept in which a fully interactive platform integrates a real-time circuit simulation with modular learning tools, providing users with comprehensive and engaging experience. Using the software, students are taken through varied modules starting from basic concepts of circuit design and moving to its advanced levels. Users are students or fans of electronics who don't want to spend a lot of money on physical parts because they are offered as tools in the virtual world. The new product serves as a new approach to increase motivation where badges and micro-credentials are obtained during learning as the way of progress motivation. A good example of revealing capability for a broad audience is scalability. It is supposed to enable instructors from various parts of the world to use its features. Also, while students play with the circuits, they receive instant correction hints, thus enabling them to learn and understand circuitry behavior and designing right away, rather than waiting to check their work. This advanced product is comprehensive and effective in improving a user's capabilities in matters concerning Digital Electronics.

In term of operation methods, the product is facilitated via a platform that allows users to design, simulate, and test circuits virtually and interactively. The users learn progressively, starting with simple circuits and advancing towards complex ones. Every module has instructional videos, quizzes and understandings check to ensure mastery of the concepts. The user receives immediate feedback on their inputs, which helps them in locating mistakes and improving their circuits' performance. As user's complete modules, which are structured to portray definite goals, achievements, badges and micro-credentials are issued. This helps users remain motivated and measure their performance. Users can share their designs and concepts with other participants of the learning community, regardless of their geographic location.

In handling a product for getting on the system, customers register on a secure internet site or a mobile application. Has internet access and knows basic level of circuit design. For interaction with circuits, the virtual environment contains tools that simulate real-life circuit parts such as the resistors, capacitors, and flip-flops. Easy construction of circuits is done via drag and drop. Projects can be saved on the cloud or extracted for later usage or distribution. Troubleshooting and help support is given in the form of a helpdesk or in-app support system.

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## Analysis and Discussion

The Innovation Diagram depicts a user's journey in the Tinkering My Circuit platform, describing the steps in which the students proceed. The process starts with selecting virtual components and goes through circuit designing, simulating, creating a physical prototype, and finally receiving feedback.

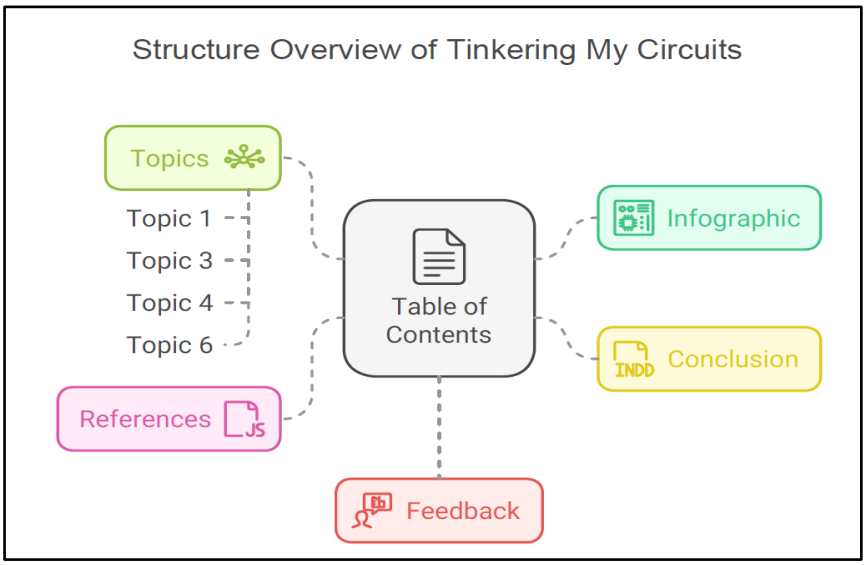


Figure 2: Structure Overview of Tinkering My Circuits

This systematic process ensures that learners interact with both the practical and theoretical dimensions of electrical learning. Each phase of the process outlines how various components work and blend together to provide a holistic educational experience. For example, in the Phase of Component Selection, the students are first trained on the selection of various electrical parts. This is followed by the Simulation phase where the designs are tested in real time. This allows for learning by doing. In the Physical Prototyping stage, the student virtual concepts are linked to the real world so that they can tinker with real stuff.

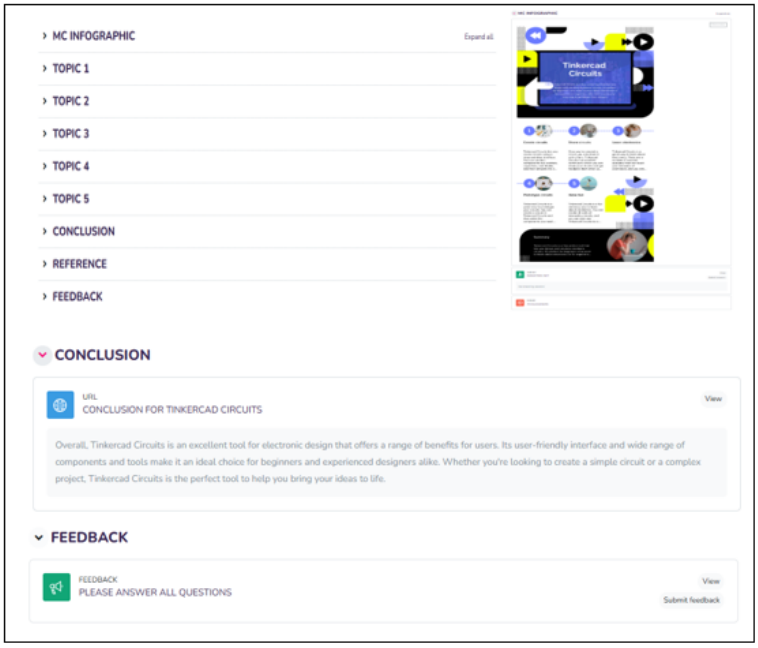


Figure 3: Contents in Tinkering My Circuits

In the end, in the Feedback phase, the students refine their work with the help of instructors or fellow students. This orderly procedure serves to strengthen retention of knowledge and enhances critical and creative thinking, as well as problem-solving abilities. Having this information allows educators and students to better understand the entire learning process in teaching electrical engineering and helps appreciate how each stage is defined to accomplish the desired learning goals.

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Discussion

1. Technical Interpretation

The creation of Tinkering My Circuit resulted in a modular and user-friendly digital learning environment that replicates the experience of designing and testing real-world circuits. Initial trials revealed a notable improvement in user engagement and comprehension, with most users completing modules in under 15 minutes. This is a marked improvement over conventional learning approaches, where it typically takes 30 to 45 minutes to understand a single concept through textbooks or passive instruction. Additionally, the platform's immediate feedback functionality allowed users to identify and fix circuit mistakes in real time, offering a more efficient alternative to traditional lab environments where feedback is usually delayed until reviewed by an instructor.

2. Implications

This innovation proves to be highly cost-effective. With a projected expense of RM 48.40 per user, it is far more economical than establishing and operating a physical electronics lab, which can cost thousands per semester. Its digital nature also makes it highly scalable, supporting future expansions such as IoT integration or AI-driven circuit optimization. Furthermore, its modular micro-credentialing framework provides learners with a structured path for skill development and certification, laying the groundwork for future upskilling initiatives.

3. Limitations

Despite its advantages, the platform is still limited by its current stage of development and academic focus. Testing so far has been limited to diploma-level students using Windows-based systems. Broader testing is needed to ensure functionality across various platforms, especially mobile devices and non-Windows operating systems. In terms of content, the platform currently concentrates on basic analogue and digital circuits. To serve more advanced learners, it will need to incorporate topics such as embedded systems and power electronics.

4. Future Work

Several improvements are planned for future iterations. Integrating machine learning could allow the system to provide real-time optimization suggestions based on user behaviour and mistakes. Another key development is the addition of adaptive learning paths, which will tailor content difficulty according to individual performance. Collaborations with industry partners are also being explored to enhance and validate the micro-credentialing system, potentially leading to certifications that are recognized beyond academia. Finally, introducing features like peer reviews and circuit design competitions aims to build a vibrant, interactive learning community.

Impact Of the Innovation Product

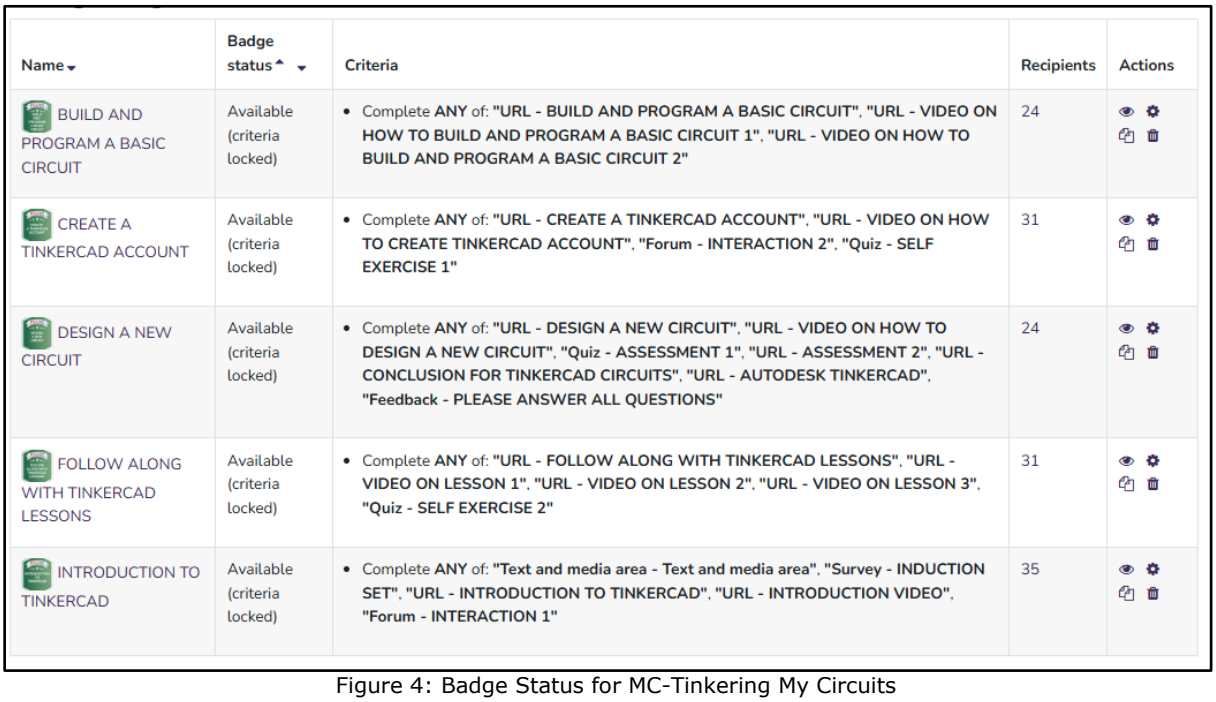
The product transforms the way digital electronics is learned and practiced. By improving accessibility, it addresses the challenge of supportive physical components or more suitable laboratory practices for students and enthusiasts by allowing practicing and circuit design practicing from any location. This feature makes the platform extremely affordable, which superbly benefits underprivileged learners. At the same time, the micro-credentialing integration structure allows users to prove their skills and, therefore, be employed or academically recognized. The gamification and feedback features drive up user engagement and increase the learning rate, which makes it fun and effective at the same time. Other users and students also benefit by using the platform for real-time teaching, as users shift from passive to active participation, fostering a global community where solutions and designs are shared. The platform goes beyond simply advancing skills by stimulating creativity and innovation and motivating users to produce fresh ideas to make an impact in the advancement of technology in electronics.

| Aspect | Before Innovation | After Innovation |
|---|---|---|
| **Practical Learning** | Limited access to physical components and laboratory facilities for circuit experiments. | Provides a virtual platform for circuit simulation and testing, accessible anytime and anywhere. |
| **Cost of Implementation** | High costs for purchasing components and equipment for hands-on experiments. | Reduces costs by using digital tools, eliminating the need for physical components. |
| **Skill Development** | Traditional learning methods lacked integration of theory with practical applications. | Combines theoretical knowledge with hands-on tinkering through interactive modules. |
| **Skill Validation** | No formal system for tracking or validating progress and skills in circuit design. | Introduces micro-credentials to recognize and validate acquired skills. |
| **Accessibility** | Learning was limited to specific institutions with resources. | Open and scalable, accessible globally to students, educators, and enthusiasts. |

| | | |
|---|---|---|
| **Error Feedback** | Errors in circuit design were difficult to diagnose without proper guidance. | Provides real-time feedback on circuit designs, enabling faster learning and improvement. |
| **Engagement** | Traditional methods were less engaging, leading to lower interest in electronics. | Gamified learning with badges and rewards increases motivation and engagement. |

Table 1: Comparison Before and After the Innovation

Achievement of Innovation Products/Innovation Ideas (Copyright/Publication of Articles/Journals/Awards Received/National/International Collaborations



| Name | Badge status | Criteria | Recipients | Actions |
|---|---|---|---|---|
| BUILD AND PROGRAM A BASIC CIRCUIT | Available (criteria locked) | • Complete **ANY** of: **"URL - BUILD AND PROGRAM A BASIC CIRCUIT", "URL - VIDEO ON HOW TO BUILD AND PROGRAM A BASIC CIRCUIT 1", "URL - VIDEO ON HOW TO BUILD AND PROGRAM A BASIC CIRCUIT 2"** | 24 | |
| CREATE A TINKERCAD ACCOUNT | Available (criteria locked) | • Complete **ANY** of: **"URL - CREATE A TINKERCAD ACCOUNT", "URL - VIDEO ON HOW TO CREATE TINKERCAD ACCOUNT", "Forum - INTERACTION 2", "Quiz - SELF EXERCISE 1"** | 31 | |
| DESIGN A NEW CIRCUIT | Available (criteria locked) | • Complete **ANY** of: **"URL - DESIGN A NEW CIRCUIT", "URL - VIDEO ON HOW TO DESIGN A NEW CIRCUIT", "Quiz - ASSESSMENT 1", "URL - ASSESSMENT 2", "URL - CONCLUSION FOR TINKERCAD CIRCUITS", "URL - AUTODESK TINKERCAD", "Feedback - PLEASE ANSWER ALL QUESTIONS"** | 24 | |
| FOLLOW ALONG WITH TINKERCAD LESSONS | Available (criteria locked) | • Complete **ANY** of: **"URL - FOLLOW ALONG WITH TINKERCAD LESSONS", "URL - VIDEO ON LESSON 1", "URL - VIDEO ON LESSON 2", "URL - VIDEO ON LESSON 3", "Quiz - SELF EXERCISE 2"** | 31 | |
| INTRODUCTION TO TINKERCAD | Available (criteria locked) | • Complete **ANY** of: **"Text and media area - Text and media area", "Survey - INDUCTION SET", "URL - INTRODUCTION TO TINKERCAD", "URL - INTRODUCTION VIDEO", "Forum - INTERACTION 1"** | 35 | |

Figure 4: Badge Status for MC-Tinkering My Circuits

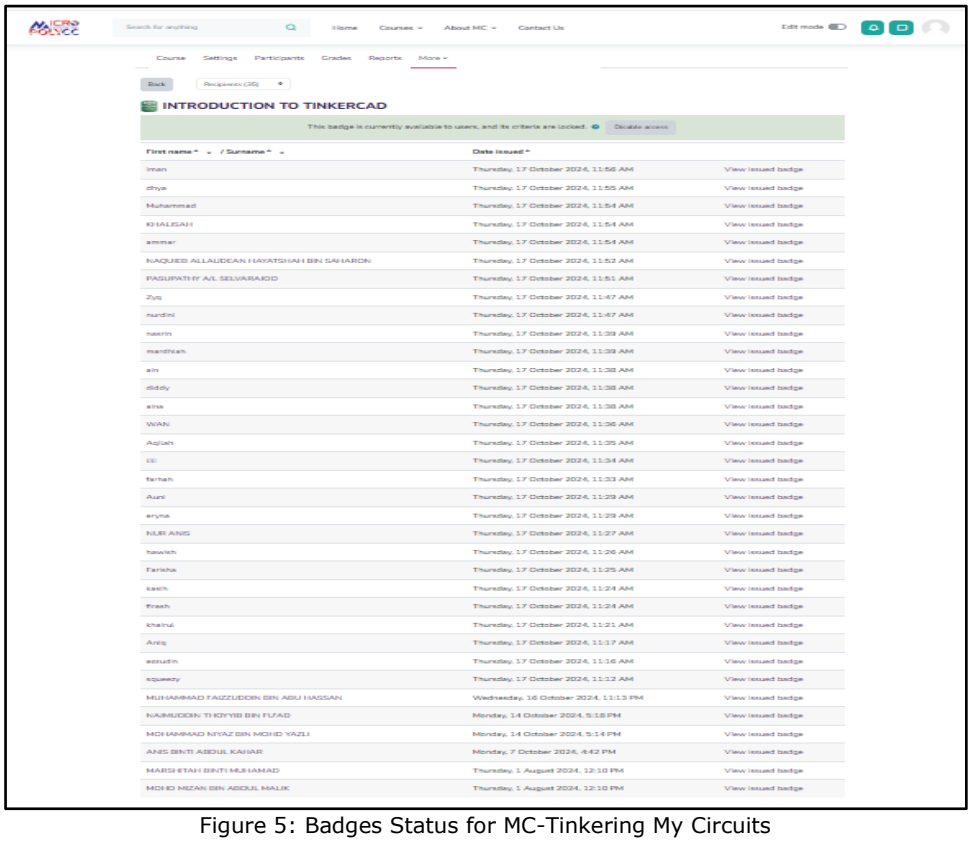



Figure 5: Badges Status for MC-Tinkering My Circuits

Program Pemindahan Kepakaran Bersama Komuniti Mualim: Internet of Things (IoT) Tinkering My Circuits, 15 Oktober 2024 (Rabu), SMK Proton City, Perak

Figure 6: Tinkering My Circuits Programme

## Conclusion and Recommendation

In conclusion, this advancement combines the understanding of concepts, reasonable pricing, and its practical usage all in a single product which changes the entire approach taken towards learning Digital Electronics. It allows users to close the gap between knowing and doing with learner driven interactive simulations, modular systems, and immediate feedback, as well as skill acknowledgement through micro-creds. This platform allows for creativity, engagement, and collaboration while providing the knowledge and skill necessary to keep pace with modern technological developments. We hope that this product serves the purpose of transforming the realm of digital education, allowing students, teachers, and inquisitive minds across the globe to use the knowledge of electronics and excel at it. Inspiring to learn throughout life, being able to innovate, and helping cultivate a new generation of thinkers who are extremely resourceful and skilled is our goal.

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