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GAMIFIED LEARNING TOOL WITH INTEGRATED FORMATIVE ACTIVITIES FOR BASIC ELECTRICITY AT DIPLOMA LEVEL

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ABSTRACT

Students at the diploma level often face challenges in retaining and applying fundamental concepts of electricity. This is largely attributable to the persistence of passive pedagogical approaches and conventional assessments that provide minimal interactivity and lack prompt feedback. Such approaches are no longer effective in meeting the learning needs of 21st century students, who thrive in digital, engaging, and self-paced environments. As a result, this disconnect contributes to reduced motivation, shallow understanding, and weak knowledge retention, particularly in technical subjects like electricity. In response to this issue, this innovation introduces a game-based learning tool developed using an online platform, specifically designed to enhance learning of basic Electricity. The tool integrates formative assessment activities, including Multiple Choice Questions (MCQ), True/False, and Fill-in-the-Blank, to support knowledge-level outcomes. By offering interactive gameplay, real-time feedback and visual engagement, the tool aims to improve conceptual clarity, promote active learning, and sustain student motivation. This innovation supports flexible and independent learning while aligning with current trends in technology-enhanced education, offering a dynamic and student-centered alternative to conventional teaching methods in technical education.

Keywords: *Game-based learning, Formative assessment, Basic electricity, Knowledge retention, Diploma-level education*

INTRODUCTION

Understanding the principles of electricity is essential in technical and engineering education, particularly at the diploma level. However, many students continue to face difficulties in grasping and applying these concepts in meaningful ways. Traditional lecture-driven instruction, which limits student engagement and critical thinking, remains a significant barrier to effective learning in this area. These conventional approaches often fail to provide opportunities for interaction, hands-on practice, and timely feedback, which are essential for promoting deeper conceptual understanding and sustained motivation. Smiderle et al. (2020) found that gamified learning environments can positively influence students' engagement, motivation, and learning outcomes, supporting the need for more interactive, student-centered approaches in technical education. Gamification in education, as highlighted by Fitria (2022), enhances learning by increasing motivation and engagement. By incorporating elements such as immediate feedback, challenge, and learner autonomy, game-based approaches provide a more interactive and student centered experience suited for digital-native learners. These methods promote active learning while enabling students to monitor their own progress through instant feedback. The shift toward Industry 4.0 and digital education post pandemic has heightened the demand for innovative, student-centered learning solutions. Technical education, in particular, must evolve to equip learners with both conceptual mastery and independent learning skills supported by technology-enhanced tools. To bridge the gap between traditional methods and modern learning needs, this study introduces Circuit Quest. It is a gamified, game-based learning tool developed to enhance conceptual understanding of basic electricity. By embedding formative assessment elements within engaging gameplay, the innovation aims to boost knowledge retention, support self-directed learning, and offer a dynamic alternative to conventional instruction.

METHODS

Circuit Quest is a gamified, web-based educational tool designed to enhance diploma students' understanding of basic electricity. Developed using interactive content platforms such as Genially, the tool requires no installation and can be accessed via a QR code on any device such as a laptop, tablet, or smartphone. This makes it highly accessible and flexible for diverse learning environments. Upon launching the game, students choose their preferred game mode, either solo or team player (up to four players). They then select one of four avatars: Captain Volt, Lightning Dash, Battro, or Blade Spark, to begin their mission. After that, players roll a virtual dice to move across a gamified Electric Grid, landing on tiles that trigger different types of learning zones. Each tile represents a specific formative assessment zone:

1. **Current Clash**: Focused on electric current concepts.

2. **Voltage Vault**: Related to voltage sources and power measurement.

3. **Ohm Zone**: Application of Ohm's Law.

4. **Circuit Checkpoint**: Differentiation and classification of series and parallel circuits.

At each zone, players must complete a challenge, which may be in the form of multiple-choice questions (MCQ), true/false prompts, or fill-in-the-blank tasks. All questions are aligned to learning outcomes at the knowledge level. Players receive instant feedback after each response, allowing them to either move forward for correct answers or step back if incorrect. Visuals, animations, sound effects, and reward elements are embedded to sustain engagement and motivation. A similar approach was adopted by Nuraminah et al. (2024), who incorporated MCQ-based quizzes within interactive learning media for electrical installation classes, demonstrating improved student understanding and engagement through multimedia integration.

This gameplay approach integrates formative assessment and gamification, which have been shown to significantly enhance student learning, engagement, and behavioral outcomes when implemented in educational contexts, as supported by Smiderle et al. (2020). The overall gameplay structure is illustrated in Figure 1, which outlines the learner's journey from launch to mission completion.

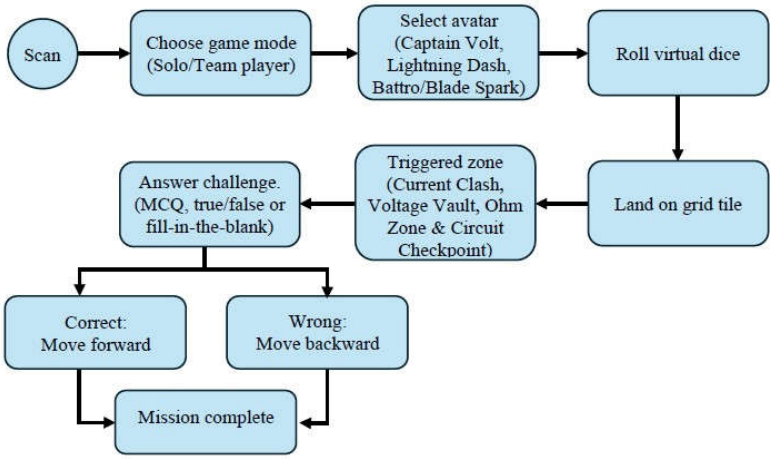

Figure 1.: Gameplay Flow of Circuit Quest

RESULTS AND DISCUSSION

Student Engagement and Feedback

Pilot classroom implementation of Circuit Quest yielded promising responses from diploma-level students. Many learners reported increased interest and clearer understanding of electrical concepts such as voltage, current, and circuit types, which they previously found difficult. The game's interactive zones, avatar-based design, and real-time feedback were consistently described as engaging and motivating. Table 1 shows representative feedback from students, reflecting how the game's features helped facilitate meaningful learning experiences.

Table 1.: Representative Student Feedback from Initial Pilot Session

Student	Feedback
1	It's really fun and engaging! I didn't get bored at all.
2	I love the visuals—they make it easier to understand.
3	Now I understand the topic, not just memorize it.
4	I'm focused. Finally understood current vs voltage

The game's multiplayer mode fostered collaboration and peer learning, echoing the principles of collaborative engagement presented by Adipat et al. (2021), who identified that social and narrative elements in game-based learning enhance motivation and group interaction. Some students also mentioned that the competitive nature of the multiplayer mode made learning feel more like a game than a classroom activity, reducing anxiety and increasing participation. Informal observations during gameplay sessions revealed high levels of concentration, peer-to-peer explanation of concepts, and voluntary replay attempts, indicating strong engagement and cognitive involvement.

Learning Benefits and Accessibility

The real-time feedback embedded in each challenge allowed students to reflect on their understanding immediately, supporting formative learning. The self-paced and replayable structure promoted independent learning and allowed learners to revisit difficult concepts, which contributed to better retention as supported by Huang & Soman (2013). One of the notable strengths of the game is its high accessibility, allowing students to engage with the platform effortlessly across multiple devices, without the barrier of installation or user authentication. This ease of use made it suitable for in-class use, group study sessions, and individual revision, aligning with Bedenlier et al. (2020), who emphasized the role of accessible, well-designed educational technologies in enhancing engagement and learner autonomy in higher education.

Several students accessed the game outside of class hours, using their smartphones during self-study time. This behavior reflects the tool's appeal and supports its role in encouraging continuous, self-directed learning beyond structured lessons. These findings are in line with Ramdani et al. (2021), who reported that the use of digital teaching materials, particularly those developed using problem-based learning, can significantly enhance students' conceptual understanding and motivation in learning basic electricity within vocational education settings. Although the pilot involved a small number of students, the feedback indicates that Circuit Quest holds strong potential to bridge the gap between passive instruction and active, learner-centered exploration.

CONCLUSION

Circuit Quest presents an effective alternative to conventional methods for teaching basic electricity at the diploma level. By integrating formative assessments within an interactive, gamified environment, it tackles common issues such as low motivation and weak conceptual understanding. Preliminary classroom feedback suggests the game is engaging, easy to use, and supports clearer understanding of core concepts. Its self-paced format and cross-device accessibility cater well to modern learners. Although tested on a small scale, the tool shows strong potential for wider adoption. Future enhancements could include expanded content and tracking features.

In the future, Circuit Quest could be expanded to cover higher-level topics such as AC circuits, instrumentation, or digital systems. The tool also holds promise for integration with analytics features to track learner progress, enabling instructors to personalize support and interventions. Its modular structure opens up possibilities for adaptation across other STEM fields, promoting scalable and sustainable innovation in technical education.

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