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ENGINEERING DYNAMICS REIMAGINED: A GAMIFIED ONLINE LEARNING PLATFORM

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ABSTRACT

Conventional teaching methods in engineering dynamics frequently do not accommodate the varied learning requirements of contemporary digital-native students. This paper presents Dynamics in Life, a gamified web-based learning platform that utilizes digital tools such as Wordwall, Kahoot, and Quizzes to improve student engagement, retention, and conceptual comprehension. The platform incorporates interactive simulations, real-time feedback, adaptive quizzes, and reward-based progress systems, aimed at tertiary learners and pre-university physics students. The platform, grounded in constructivist learning theory and gamification frameworks, targets cognitive and affective learning domains. Following Sustainable Development Goals (SDG 4 and SDG 9), the solution fosters equitable access to more effective STEM education. An evaluation involving 78 students in the initial learning outcome study revealed statistically significant enhancements in understanding and motivation, while a subsequent reflection survey with 222 students provided more profound insights into engagement, development challenges, and SDG awareness. In conclusion, Dynamics in Life demonstrates that gamified, web-based learning can effectively transform the teaching of complex engineering concepts and inspire greater student engagement.

Keywords: *Gamified Learning, STEM Education, Engineering Dynamics, Interactive Learning*

INTRODUCTION

In recent years, engineering education has faced growing concern over students' declining engagement and difficulty mastering complex theoretical subjects like dynamics. Traditional lecture-based approaches often fail to capture student interest, resulting in poor retention and limited real-world application. These challenges are particularly evident in engineering dynamics, where abstract

principles such as kinematics and kinetics are central yet conceptually demanding. Current research in engineering education emphasizes the need for innovative, technology-driven strategies to bridge the gap between theory and practice. Among these, gamification and interactive learning platforms have emerged as promising solutions to enhance engagement and learning outcomes (Freeman et al., 2014; Deterding et al., 2011). Several studies have explored using Kahoot, Wordwall, and online quizzes to increase student motivation and participation in STEM courses (Plump & LaRosa, 2017). However, despite their popularity, few initiatives have successfully integrated these tools into a unified, scalable, and subject-specific mobile learning platform tailored to engineering dynamics. This paper presents Dynamics in Life, a gamified mobile app designed to transform the learning experience for engineering dynamics students. The app incorporates adaptive quizzes, simulations, real-time feedback, and level-based challenges to support self-paced, interactive learning. Our findings demonstrate that students using this platform showed increased engagement, improved conceptual understanding, and greater motivation to apply dynamics principles in problem-solving.

METHODS

This methodology outlines the approach to developing and evaluating a gamified learning platform for engineering dynamics. Recognizing the limitations of traditional teaching methods, the project aimed to create a more engaging and effective learning environment through technology-enhanced strategies. The development began by integrating familiar tools such as Wordwall, Kahoot, and Quizzes into a structured, game-based learning sequence tailored to student needs. Care was taken to ensure the content aligned with core dynamics topics such as kinematics, kinetics, and Newtonian motion, and was adaptable across various educational settings. Each game module was carefully tested to ensure it provided real-time feedback, adaptive progression, and challenge-based learning. The methodology builds upon successful gamification frameworks referenced in prior educational research, supporting its use as an active learning intervention. The platform was refined through student feedback and performance metrics to ensure high usability and academic relevance. Quantitative data from surveys and in-class assessments were collected to evaluate student engagement and understanding. One challenge was ensuring consistent digital access for all students, which was addressed by optimizing the platform for low-bandwidth environments.

RESULTS AND DISCUSSION

Applying innovative teaching strategies is critical to addressing engineering education's persistent challenges, particularly in increasing student engagement and conceptual understanding of complex topics such as dynamics. Based on constructivist and motivational theories, gamified learning approaches have shown great potential for transforming passive learning environments into interactive and impactful educational experiences. Evaluating the effectiveness of such techniques is critical for informing future curriculum design and ensuring that technological interventions have a meaningful impact on learning outcomes. The following section presents the demographic profile of participants

and analyzes their feedback to determine the effect of the gamified learning platform developed in this study.

Table 1 shows the 222 students' demographic profile in the gamified engineering dynamics learning platform reflection survey. Of the respondents, 49.5% were male (110 students) and 50.5% were female (112). The majority were in Semester 4 (53.2%) and Semester 5 (41.0%), with smaller proportions in Semesters 6 (2.3%), 7 (1.4%), and 8 (0.5%). Regarding year of study, 43.2% were Year 2 students, followed by 41.4% in Year 3, 9.9% in Year 4, and 5.4% in Year 1. Regarding educational background, 75.7% held diplomas, 18.9% came from matriculation, while the remaining students held qualifications such as foundation (1.8%), bachelor's degree (1.4%), degree (1.4%), diploma in science (0.9%), bachelor's in civil engineering (0.5%), and diploma science (0.5%). This distribution reflects a diverse sample across gender, academic levels, and prior educational pathways relevant to the study context.

Table 1.: The demographic profile of students involved in the gamified engineering dynamics learning platform reflection survey

Demographic Aspect	Category	Count	Percentage (%)
Total respondents	-	222	100
Gender	Male	110	49.5
	Female	112	50.5
Semester	4	118	53.2
	5	91	41.0
	6	5	2.3
	7	3	1.4
	8	1	0.5
Year of study	Year 1	12	5.4
	Year 2	96	43.2
	Year 3	92	41.4
	Year 4	22	9.9
Educational background	Diploma	168	75.7
	Matriculation	42	18.9

Demographic Aspect	Category	Count	Percentage (%)
	Foundation	4	1.8
	Bachelor's Degree	3	1.4
	Degree	3	1.4
	Diploma in Science	2	0.9
	Bachelor's in civil engineering	1	0.5
	Diploma Sains	1	0.5

Implementing the gamified learning platform for engineering dynamics yielded positive outcomes (See Table 2). Based on the feedback collected, over 80% of students found the game-based approach practical or effective in enhancing their learning experience. Furthermore, 87.8% of students agreed that gamification was effective for mastering dynamics principles. In addition, 79% reported that the gamified platform helped them understand complex engineering topics more clearly, demonstrating increased engagement and deeper cognitive processing. Nearly 78% of participants stated they better understood sustainability concepts (SDGs) through this approach, suggesting that embedding real-world themes into learning modules can broaden students' awareness and foster interdisciplinary thinking.

Table 2.: Students' feedback and evaluation results for the gamified engineering dynamics learning platform

Aspect Evaluated	Key Findings	Percentage (%)
Overall effectiveness	Found the game-based approach practical or effective	>80
Mastery of dynamics principles	Agreed, gamification was effective for mastering dynamics	87.8
Conceptual understanding	Reported a better understanding of complex engineering topics	79
Understanding of SDGs (4 & 9)	Gained a better understanding of sustainability concepts	78
Challenges faced	Difficulty designing meaningful questions	45
	Faced technical limitations/lack of platform experience	30
Strategies to overcome challenges	Used brainstorming sessions	65

Aspect Evaluated	Key Findings	Percentage (%)
Balancing learning and entertainment	Conducted peer testing	52
	Self-learned via online tutorials	28
	Applied gamification techniques (points, badges, challenges)	60
	Integrated memes and visuals	35
	Aligned questions to learning objectives	72
	Structured games with progressive difficulty levels	49
Perceived benefits	Made dynamics more interactive and less boring	83
	Helped visualise forces and motion	78
	Encouraged active participation and practical application	65
	Enhanced understanding of abstract concepts through animations	58
Teamwork and collaboration	Practiced clear communication, task delegation, mutual respect	70
	Divided tasks based on strengths	68
	Faced challenges in time management and workload distribution	31
Recommendations for improvement	Suggested adding more questions or levels	55
	Recommended adaptive difficulty levels	47
	Proposed improved visuals and interface design	39
	Suggested storytelling integration	28
	Proposed adventure-based gameplay	24
	Recommended enhanced feedback systems	32
Promotion of SDG4 (Quality Education)	Believed the game fostered critical thinking, problem-solving, and conceptual understanding	>80
Promotion of SDG9 (Industry, Innovation, Infrastructure)	Noted relevance to real-world engineering applications (e.g. automotive, rocket propulsion)	65

These results collectively highlight that gamified learning offers a meaningful alternative to traditional methods. The platform's interactive elements, such as immediate feedback, challenge missions, and adaptive quizzes, made learning enjoyable and enhanced student motivation and retention. However, one limitation observed was the dependency on digital access, which may affect scalability in low-connectivity environments. Despite this, the model remains adaptable, scalable, and relevant across diverse educational settings, especially for STEM and engineering education.

CONCLUSION

The advancement of Dynamics in Life represents a pivotal progression in the pedagogy of engineering dynamics. This innovation effectively enhances student engagement, improves conceptual understanding, and connects theoretical knowledge with real-world application by incorporating gamification and interactive digital tools into the learning process. The favourable responses from students underscore the efficacy and pertinence of this method in contemporary engineering education. Due to its scalability, cost-effectiveness, and adaptability across various educational tiers, Dynamics in Life possesses significant potential for widespread integration in STEM education. The platform can serve as a prototype for other disciplines, fostering a more engaging, student-centered, and future-oriented educational environment. In conclusion, the results demonstrate that gamified learning significantly enhances student engagement, understanding, and motivation in engineering dynamics education.

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