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Enhancing Motivation and Achievement through Gamified Learning in Vocational Electropneumatic Education

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Abstract: This study investigates the influence of gamified learning using Quizizz on students' motivation and academic achievement in Electropneumatic Control Systems at a vocational high school. The research was conducted in response to low student motivation and academic performance in complex technical subjects. A quasi-experimental design with a non-equivalent pretest-posttest control group was employed. The experimental group (n = 25) received gamified instruction via Quizizz, while the control group (n = 24) was taught using conventional methods. Data were collected using a validated motivation questionnaire (34 items) and a learning outcome test (38 items). Gain scores (posttest minus pretest) were analyzed using Independent Samples t-Test. Results revealed that the experimental group had significantly higher motivation scores ($t = 4.396$, $p < 0.05$) and better academic achievement ($t = 3.275$, $p < 0.05$) compared to the control group. These findings suggest that incorporating gamification strategies into technical instruction can effectively enhance both student motivation and academic outcomes.

Keywords: Gamification-Based Learning; Learning Motivation; Learning Outcomes

Introduction

The rapid evolution of 21st-century education, particularly in vocational settings, calls for the adoption of innovative and student-centered instructional approaches (Velmurugan et al., 2025). In technical subjects such as Electropneumatic Control Systems, students are expected not only to comprehend complex theoretical concepts but also to translate them into practical, real-world applications (Setyawan et al., 2025). This dual demand for cognitive understanding and hands-on proficiency makes effective pedagogy critical to student success (Natasya et al., 2025). To meet these demands, the learning process must be engaging, relevant, and adaptable to diverse learner profiles (Aditya & Suranto, 2024).

However, current teaching practices in many vocational schools remain dominated by traditional methods such as lecture-based delivery and the use of manual worksheets (Purnomo et al., 2024). These conventional approaches often result in passive learning experiences, where students struggle to connect abstract theories with practical tasks (Salimi & Mohammadzad, 2025). In turn, this disconnection weakens comprehension, reduces engagement, and ultimately hampers academic performance (Voronkova et al., 2023). Moreover, students in vocational schools often come from varied socio-economic and academic backgrounds, which necessitates teaching strategies that are inclusive, differentiated, and motivating (Fitrianto & Saif, 2024). Without such approaches, learners may face significant barriers in mastering technical competencies (Triyono & Rijanto, 2020).

This issue is clearly observed at SMK Negeri 1 Pariaman. Recent school records indicate a decline in student performance in the Electropneumatic Control Systems course, with the percentage of students achieving the minimum passing grade (KKM)

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decreasing from 47.08% in 2023/2024 to 42.86% in 2024/2025. In parallel, internal surveys show that only 40–45% of students demonstrate high levels of motivation to learn. These findings highlight a pressing need to revitalize instructional strategies, particularly in technically challenging courses where engagement is often low (Shofiyani, 2025).

To address these challenges, gamified learning has emerged as a compelling pedagogical solution (Sikora et al., 2024). By integrating game mechanics—such as points, leaderboards, badges, and instant feedback—into educational activities, gamification has been shown to enhance motivation, participation, and learning outcomes (Quyen & Chanh, 2025). It aligns well with students' natural affinity for competition and interactive experiences, making learning more enjoyable and meaningful (Ikpat, 2025). Research has indicated that gamification can foster deeper learning by encouraging repetition, enhancing attention, and promoting mastery of both conceptual and procedural knowledge, which are essential in vocational education (Renata et al., 2024).

Among the various digital platforms available, Quizizz has garnered attention due to its user-friendly interface, real-time feedback, and capacity for formative assessment (Ivanović, 2025). It allows educators to design interactive quizzes tailored to student needs, enabling personalized and engaging instruction (Rachmawati et al., 2025). Features such as timers, rankings, and customizable content further create a competitive yet supportive learning environment (Rulismi et al., 2024; Utami & Iryanti, 2025). Despite these strengths, the implementation of Quizizz in technical vocational subjects—especially those involving complex content like electropneumatics—remains underexplored in empirical research (Nazar & Ismail, n.d.).

The lack of studies examining the role of gamified learning in technical courses represents a critical gap in the literature (Pransisca & Pahru, 2024). Given that vocational education aims to prepare students for industry demands, instructional innovations must not only capture students' interest but also develop their readiness to solve real-world problems (Pramudita et al., 2023). In subjects like Electropneumatic Control Systems, which require sequential thinking and conceptual clarity, platforms like Quizizz offer promising potential for creating immersive and responsive learning environments (Caramihai et al., 2025).

Therefore, this study seeks to investigate the effectiveness of gamified learning using Quizizz in enhancing student motivation and academic achievement in Electropneumatic Control Systems classes at SMK Negeri 1 Pariaman. By measuring both affective and cognitive outcomes, the study aims to provide empirical evidence for integrating gamification into technical vocational education (Mulyati & Evendi, 2020). The findings are expected to contribute valuable insights for educators, curriculum developers, and policymakers seeking to improve learning outcomes through innovative and student-centered strategies (Putra et al., 2024).

Method

This study employed a quasi-experimental design, selected due to practical and ethical constraints that made random assignment of participants to groups unfeasible (Phitayakorn et al., 2024) The research involved two intact classes: one was designated as the experimental group, and the other as the control group (Wang & Xue, 2024) The independent variable in this study was gamification-based learning using Quizizz, while the dependent variables were students' motivation and academic achievement, measured in terms of gain scores (i.e., the difference between posttest and pretest results) (Mahdiyyah & Meilana, 2025). A non-equivalent groups pretest-posttest design was applied. Both groups completed a pretest to assess baseline levels of motivation and learning outcomes (Dewi et al., 2024). The experimental group then received instruction incorporating gamified learning through Quizizz, while the control group continued with conventional teaching methods (Jamilah, 2025). After the instructional period, both groups completed a posttest using the same instruments (Susilawati et al., 2021). The design of the study is illustrated in table 1.

Table 1. Design Illustrated

Group	Pretest	Treatment	Posttest
Experimental	O1	X (Gamification)	O2
Control	O3	– (Conventional)	O4

O1/O3: Pretest (motivation and learning outcomes)
O2/O4: Posttest (motivation and learning outcomes)
X: Gamification-based learning using Quizizz

Effect of gamified learning was determined by calculating gain score, i.e., difference between posttest and pretest results (Astuti et al., 2025). To evaluate differences in motivation and academic improvement, an Independent Samples t-Test was applied (Chaniago et al., 2025). Statistical significance was determined by comparing calculated t-statistic (t_h) against critical t-value (t_t = 2.012) (Fatimatuzzahro & Ahmadi, 2025).If $t_h > t_t$, null hyposis (H_0) was rejected, indicating a significant effect of gamification-based learning. following flowchart illustrates overall procedure of this study, starting from pretest, followed by application of different teaching methods in control and experimental

groups, and ending with posttest data analysis (Tyas, 2025).

To determine the effectiveness of the intervention, gain scores were calculated for both groups (Rooshadiya & Widiyatmoko, 2025). The differences between groups in terms of improvement were then analyzed using the Independent Samples t-Test (Yusuf et al., 2025). Detailed procedures for statistical analysis are described in the following section. The overall research procedure is illustrated in the flowchart shown in Figure 1.

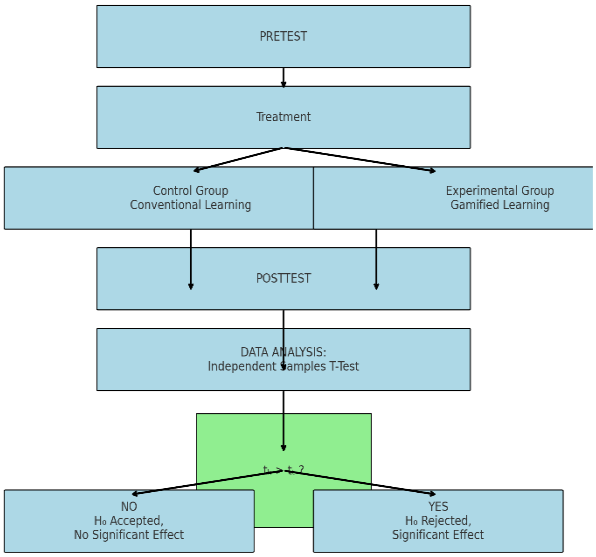

Figure 1 Flowchart

Result and Discussion

The research was conducted at SMK Negeri 1 Pariaman during 2024/2025 academic year, specifically involving students from class XI TOI 2 as experimental group (25 students) and XI TOI 1 as control group (24 students). This study aimed to examine effect of gamified learning on students' motivation and academic achievement in Electropneumatic Control Systems. Data were gared through pretest and posttest assessments administered to both experimental and control groups, and analysis was conducted using SPSS Version 24. This section begins with a descriptive analysis of research data, followed by inferential statistics to determine significance of impact. Normality and homogeneity tests were conducted prior to hyposis testing using independent sample t-test method.

Data Descriptive

Descriptive analysis was conducted to provide an overview of data related to students' learning motivation and learning outcomes before and after treatment.

Descriptive Statistics of Student Learning Motivation

To assess impact of gamified learning on student motivation, a descriptive statistical analysis was performed. This analysis compared students' motivation levels prior to and following application of Quizizz-based gamification. results of this analysis as follows Table 2.

Table 2. Descriptive Statistics of Student Learning Motivation

Kel.	E			K		
	Pre	Post	Gain	Pre	Post	Gain
Total	1901	2722	-	1821	2342	-
Mean	75.72	108.88	33.16	75.88	97.58	21.7
Max	84	123	-	87	122	-
Min	66	95	-	61	86	-
SD	5.24	8.54	-	6.85	9.96	-
Varians	27.46	72.94	-	46.89	99.29	-

As shown in Table 3, experimental group had an average pretest score of 56.28, which rose to 81.92 following implementation of gamified learning. Meanwhile, control group's average pretest score was 55.33 and increased to 73.25 after undergoing conventional instruction. se findings suggest a notable improvement in student learning outcomes, particularly in group exposed to gamification-based learning.

Descriptive Statistics of Learning Outcome Tests

In addition to measuring motivation, this study also examined effect of gamification on students' learning outcomes in Electropneumatic Control Systems course was assessed using pretest and posttest scores. A comprehensive summary of test results as follow Table 3.

Table 3 Descriptive Statistics of Learning Outcome Tests

Kel.	E			K		
	Pre	Post	Gain	Pre	Post	Gain
Total	1405	2053	-	1326	1758	-
Mean	56.28	81.92	25.64	55.33	73.25	17.92
Max	76	95	-	66	87	-
Min	42	68	-	39	63	-
SD	9.35	7.17	-	8.79	6.78	-
Varians	87.46	51.41	-	77.36	46.02	-

As follows Table 3, experimental group obtained an average pretest score of 56.28 in learning outcomes assessment. Following application of gamification-based learning, a notable improvement was observed, posttest average increased to 81.92. Meanwhile, control group had a pretest average of 55.33, which increased to 73.25 after receiving conventional learning.

Data Analysis

This data analysis section presents scores of students' learning motivation criteria and learning outcome test scores in each group to determine effect of gamification-based learning. analysis employed is using SPSS Version 24.

Normality Test

The resulting output was interpreted to determine wher data followed a normal distribution. To assess normality, Shapiro-Wilk test was applied (Yagin et al., 2024). According to decision criteria, if significance value exceeds 0.05, data are considered normally distributed; whereas a value 0.05 indicates that data deviate from normality (Cardoso et al., 2025) . results of normality test using SPSS version 24 as follows Table 4.

Table 4. Normality Test

Variable	Group	Shapiro-Wilk Statistic	df	Sig
Learning Motivation Gain	E	0.972	25	0.703
	K	0.885	24	0.101
Learning Outcome Gain	E	0.969	25	0.616
	K	0.933	24	0.116

Table 4 shows that significance values for gain in learning motivation for experimental and control groups were 0.703 and 0.101, respectively. se results indicate that difference between pretest and posttest motivation scores for both groups was normally distributed since significance values were greater than 0.05. Similarly, significance values for gain in learning outcomes were 0.616 (experimental) and 0.116 (control), confirming that gain scores for learning outcomes were also normally distributed.

Homogeneity Test

Anor assumption that must be met before conducting an independent sample t-test is data homogeneity (Vankelecom et al., 2024). This homogeneity test was conducted using Levene's test in SPSS version 24. decision rule for this test is as follows if significance value is greater than 0.05, data are considered homogeneous (Pusbelina & Sutrisno, 2025); orwise, y are not. results of homogeneity test for gain in learning motivation and learning outcomes as follows Table 5.

Table 5. Homogeneity Test

Variable	Levene's F	Significance
Learning Motivation Gain	2.337	0.133
Learning Outcome Gain	2.846	0.098

As shown in Table 5, significance values for gain in learning motivation and learning outcomes were 0.133 and 0.098, respectively. Since both values are greater than 0.05, it can be concluded that data from experimental and control groups are homogeneous (Ratu et al., 2025).

Hyposis Test

Effect of Gamification-Based Learning on Students' Learning Motivation

To assess significance amification-based learning on students' motivation in Electro-Pneumatic Control Systems at vocational schools, an Independent Samples t-test was conducted using SPSS version 24. The analysis focused on gain scores, obtained by subtracting pretest scores from posttest scores for both the experimental and control groups. Summary of analysis as follows Table 6.

Table 6 Effect of Gamification-Based Learning on Students' Learning Motivation

Variable	t	df	Sig. (2-tailed)
Learning Motivation Gain	4.396	47	0.000

As follows Table 6, The Independent Samples t-test showed a significant result ($p = 0.000 < 0.05$) with a t-value of 4.396, exceeding the critical value of 2.012. Thus, the null hypothesis is rejected, confirming that gamification-based learning significantly enhances student motivation. The experimental group outperformed the control group in motivation scores, supporting the first hypothesis. Analysis was as follows gain scores from both groups. results as follows Table 7.

Table 7 Effect of Gamification-Based Learning on Students' Learning Outcomes

Variable	T	df	Sig. (2-tailed)
Learning Outcome Gain	3.275	47	0.002

As follows analysis shown in Table 7, gamification-based learning had a statistically significant effect on students' learning outcomes in of Electro-Pneumatic Control Systems ($p = 0.002 < 0.05$).

Conclusion

Based on the results of data analysis, gamification-based learning is associated with a significant improvement in students' learning motivation and learning outcomes in the Electro-Pneumatic Control System subject at vocational high school. The experimental group, which received instruction through gamified learning strategies, demonstrated higher gains in motivation and academic performance than the control group taught with conventional methods. These findings suggest that integrating gamification into the learning process can be a promising approach to enhance student engagement and achievement, particularly in technical and vocational education contexts.

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