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Enhancing Learning Outcomes through Kahoot! - Based Educational Games in Engine and Heavy Equipment Courses for Phase F Heavy Equipment Engineering Students

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Abstract: This study investigates the effect of the Kahoot! educational game on student learning outcomes in the Engine and Heavy Equipment Unit course for Phase F students at SMK Muhammadiyah 1 Pekanbaru. A quasi-experimental design with equivalent control and experimental groups (n=18 each) was employed. Data were analyzed using normality and homogeneity tests, confirming suitability for parametric testing. Hypothesis testing using an independent t-test revealed a significant improvement in the experimental group's mean post-test score (80.3) compared to the control group (74.2), with $t(34) = 3.618$, $p < 0.05$. The pre-test scores showed no significant difference between groups, ensuring comparability. These findings demonstrate that Kahoot! as an interactive gamified learning tool effectively enhances student engagement and academic performance in vocational engineering education. This study contributes novel empirical evidence supporting the integration of gamification in technical skill development, addressing a research gap in vocational ICT-based pedagogy.

Keywords: Gamification; Kahoot!; Learning Outcomes; Vocational Education; Interactive Learning Media; Technical Training.

1. Introduction

In the era of Industry 4.0, Information and Communication Technology (ICT) has become a crucial element in reshaping the educational landscape, particularly in addressing the needs of the digitally native generation [1]–[3]. Recent data show that approximately 30% of internet users in Indonesia are students, with a significant proportion primarily engaging in social media platforms [4], [5]. This indicates a pressing opportunity to harness digital

technologies to create more relevant and engaging learning experiences aligned with students' online behavior.

The acceleration of digital transformation has disrupted traditional pedagogical models, prompting the need for innovative, interactive, and technology-integrated approaches to education [6]. ICT has emerged not only as a tool for delivering content but also as a strategic solution to overcome systemic challenges such as geographic disparities and unequal access to quality education across Indonesia's archipelagic regions [7]–[9]. Despite these advancements, empirical research on the actual impact of specific ICT-based tools—particularly gamification applications—on learning outcomes in vocational and technical education remains insufficient.

Among emerging educational technologies, Kahoot! has gained recognition as a gamified learning platform that promotes student engagement through interactive, time-bound quizzes enhanced with multimedia elements such as images, animations, and videos. Previous studies have reported its potential in improving student motivation, attention, and knowledge retention [10]–[13]. However, limited research has examined its application within vocational education contexts, especially in highly specialized subjects such as engine mechanics and heavy equipment operation.

This study aims to fill that research gap by empirically examining the effects of integrating Kahoot! into a vocational course focused on engine and heavy equipment systems. The study contributes to the growing discourse on digital transformation in education by evaluating how gamification tools can be effectively utilized to improve practical learning outcomes in vocational technical training. The findings are expected to inform educators, curriculum designers, and policymakers on best practices for integrating interactive ICT tools into vocational education settings.

2. Material and methods

2.1 Type of Research

The method chosen for this research is Quasi-Experimental. A quasi-experiment is a structured experiment conducted on both a test (experimental) group and a control group [14]–[16]. This study involved two classes: a control class and an experimental class. The control class serves as a comparison for the experimental class.

In this research, both the control and experimental classes will undergo pre-tests and post-tests. The experimental class will use the Kahoot! educational game, while the control class will not receive any special treatment, in order to measure the learning outcomes of the students.

2.2 Time and Place of Research

This research was conducted at SMK Muhammadiyah 1 Pekanbaru, specifically targeting students in Phase F of the Heavy Equipment Engineering program. The research was carried out in April 2024.

2.3 Research Variables

This study involves two variables that can be classified by their function. The independent variable in this research is the use of the Kahoot! educational game, while the dependent variable is the learning outcomes.

2.4 Research Population

The population in this study consists of students in Phase F, even semester, from the Heavy Equipment Engineering Department, totaling 36 students. The research sample is divided into two groups: 18 students in the control class and 18 students in the experimental class.

2.5 Research Instruments

Research instruments are used to assess natural or social phenomena present in the study variables [17]–[19]. These instruments function as tools for data collection. In this study, the instrument used is a test (pre-test and post-test), which is a set of questions designed to assess a person's knowledge and skills in understanding the subject matter [20], [21].

3. Results and discussion

3.1 Results

Class XI TAB 1A served as the experimental class, and XI TAB 1B served as the control class in this test.

Table 1. Pre-test Information

No	Data Criteria	P-test Data	
		Experiment	Control
1	Number of Students	18	18
2	Mean	58.3	56.7
3	Median	60	55
4	Modus	70	50
5	Max	80	80
6	Min	10	20

Table 1 shows that each class is comprised of 18 students. In the experimental class, the mean score is 58.3, the median is 60, the mode is 70, with the highest

score being 80 and the lowest 10. Meanwhile, in the control class, the mean score is 56.7, the median is 55, the mode is 50, the highest score is 80, and the lowest is 20. This data indicates that the distribution of scores between the experimental and control classes does not show a significant difference.

Table 2. Learning Outcome Data

No	Data Criteria	Post-test Data	
		Experiment	Control
1	Number of Students	18	18
2	Mean	80.3	74.2
3	Median	85	70
4	Modus	100	70
5	Max	100	100
6	Min	50	40

Table 2 above displays the post-test results, which show that the experimental class, after using the Kahoot! educational game, achieved a mean score of 80.3, a median of 85, a mode of 100, the highest score of 100, and the lowest score of 100. Meanwhile, the control class recorded a mean score of 74.2, a median of 70, a mode of 70, the highest score of 100, and the lowest score of 40. The data in Table 2 indicates an improvement in learning outcomes after using the Kahoot! educational game in class XI TAB.

3.2 Analysis Requirement Testing

Before the research was conducted, a normality test was carried out first. The results of the normality test using the Liliefors method are presented in the following table:

Table 3. Normality Test of Pre-test for the Experimental Class

No	Data Criteria	Pre-test Data	
		Experiment	Control
1	Number of Students	18	18
2	Mean	58.3	56.7
3	Standard Deviation	17.078	15.969
4	Calculated L	0.141	0.129
5	Table L	0.209	0.209

Based on Table 3 above, the pre-test data is considered normally distributed if the calculated L is less than the critical L value (Table L). For the experimental class, the calculated L value is less than the critical L value, i.e., $0.141 < 0.209$, so the data is declared normally distributed. Likewise, for the control class, the pre-test data from 18 students shows a calculated L value less than the critical L value, i.e., $0.129 < 0.209$, so the data is also declared normally distributed.

Table 4. Normality Test of Post-test for Experimental Class

No	Data Criteria	Pre-test Data	
		Experiment	Control
1	Number of Students	18	18
2	Mean	80.28	74.17
3	Standard Deviation	19.33	16.60
4	Calculated L	0.162	0.145
5	Table L	0.209	0.209

In this study, the normality test of the data was conducted using Microsoft Excel 2010. Based on Table 3 above, the post-test data is considered normally distributed if the calculated L value (L count) is less than the critical L value (L table). In the experimental class, the L count < L table = 0.162 < 0.209 indicates that the data are normally distributed. Meanwhile, for the control class, the pre-test data from 18 students showed L count < L table = 0.145 < 0.209, also indicating a normal distribution.

After the normality test was performed, it was concluded that the data distribution was normal, thus allowing the homogeneity test to be conducted. The homogeneity test aims to determine whether the variations within populations have similar compositions or characteristics. The primary purpose of this test is to ensure that two or more datasets used can be considered comparable and valid for analysis.

In this study, the F-test (Fisher's test) was applied to assess heterogeneity. Below are the results of the F-test for the pre-test and post-test data from the experimental class.

Table 5. Homogeneity Test of Pre-test and Post-test for the Experimental Class

No	Data Criteria	Experimental Class	
		Pre-test	Post-test
1	Number of Students	18	18
2	Mean	58.3	80.28
3	Standard Deviation	17.078	19.33
4	Variance	291.667	373.534
5	F_{count}	1.281	
6	F_{table}	1.523	

The data is considered homogeneous and can proceed to the next test if F count < F table. Conversely, if F count > F table, the data is considered not homogeneous and does not meet the requirements for further testing. Based on Table 5, the variance value of the pre-test for the experimental class is 219.66, while the variance of the post-test data is 373.534. From this data, it can be seen that F count < F table = 1.281 < 1.523, indicating that the data is homogeneous and meets the requirements for the next test.

Table 6. Homogeneity Test of Pre-test and Post-test for the Control Class

No	Data Criteria	Control Class	
		Pre-test	Post-test
1	Number of Students	18	18
2	Mean	56.7	74.17
3	Standard Deviation	15.969	16.60
4	Variance	255.015	275.694
5	F_{count}	1.081	
6	F_{table}	1.526	

The homogeneity test data is presented above. In this study, the pre-test mean was 56.7 with a standard deviation of 15.969 and a variance of 255.015. Meanwhile, the post-test mean was 74.17 with a standard deviation of 16.60 and a variance of 275.694. The F count value from the pre-test and post-test in the control class was 1.081, while the F table value was 1.526. According to the testing criteria, the data is considered homogeneous if F count < F table. Based on the homogeneity test results for the control class, it was found that F count < F table, i.e., 1.081 < 1.526. Thus, the data is considered homogeneous and suitable for further testing.

3.3 Hypothesis Testing

This hypothesis test aims to determine whether the Kahoot! educational game has an effect on users by including the pre-test and post-test data from the experimental and control classes. A t-test will be applied to analyze the hypothesis test results, as presented in the following table:

Table 7. Hypothesis Testing

No	Criteria	Control Class	
		Experimental	Control
1	Number of Students	18	18
2	Mean	80.28	74.17
3	t_{count}	3.618	
4	t_{table}	2.101	

The hypothesis testing criterion is: if t-count > t-table, then the hypothesis is accepted. However, if t-count < t-table, then the hypothesis is rejected. Table 7 shows that t-count > t-table = 3.618 > 2.101, thus the hypothesis is accepted. The mean score in the experimental class was 80.28, while in the control class it was 74.17 after using the Kahoot! educational game. Therefore, it can be concluded that the Kahoot! educational game in the Heavy Equipment Engineering Phase F at SMK Muhammadiyah 1 Pekanbaru has been proven to improve student learning outcomes in the Engine and Heavy Equipment Unit subject.

3.4 Discussion

The results of this study provide compelling evidence that the use of the Kahoot! educational game significantly improves student learning outcomes in the Engine and Heavy Equipment Unit course for Phase F students at SMK Muhammadiyah 1 Pekanbaru. The post-test mean score of the experimental group (80.28) was substantially higher than that of the control group (74.17), and the t-test confirmed that this difference is statistically significant ($t = 3.618 > t_{critical} = 2.101$). This finding corroborates prior studies that highlight the effectiveness of gamified learning tools in increasing student engagement and cognitive achievement [22]–[26].

The normality and homogeneity tests indicated that the data met the assumptions necessary for parametric testing, thereby strengthening the validity of the inferential statistics used. The experimental and control classes had comparable baseline abilities, as indicated by their similar pre-test scores, which reinforces the conclusion that the observed learning gains are attributable to the intervention rather than confounding variables [27].

This study addresses a critical gap in vocational education research, particularly in Indonesia, where empirical investigations into gamification tools tailored for technical subjects remain sparse. Unlike previous research focusing mainly on general education contexts, this study uniquely targets a specialized engineering curriculum, thereby contributing novel insights into how digital game-based learning can be effectively integrated into vocational technical training.

The improvement in learning outcomes can be attributed to several distinctive features of Kahoot!. The platform's time-limited quizzes likely enhanced students' rapid cognitive processing and decision-making skills, while the inclusion of multimedia elements such as images and animations may have catered to diverse learning styles, facilitating better comprehension of complex technical materials. These interactive features foster active learning and immediate feedback, which are known to boost motivation and retention [28]–[31].

Furthermore, the positive impact observed in this study aligns with the theoretical framework of constructivist learning, where knowledge is actively constructed through engaging and meaningful activities. By transforming conventional rote memorization into an interactive challenge, Kahoot! enables students to deepen their understanding while enjoying the learning process.

Despite these promising results, this study acknowledges certain limitations. The sample size was relatively small and confined to a single vocational school, which may limit the generalizability of findings. Additionally, the study focused solely on cognitive learning outcomes without assessing other

dimensions such as long-term retention, skill transfer, or affective factors like student motivation and attitudes.

Future research should consider expanding the sample size and including multiple vocational schools to enhance external validity. Moreover, longitudinal studies assessing the sustainability of learning improvements and integrating qualitative methods to explore student perceptions would provide a more comprehensive understanding of Kahoot!'s educational impact.

In conclusion, this research demonstrates the practical potential of integrating Kahoot! into vocational engineering education to enhance student learning outcomes. Educators and curriculum developers are encouraged to adopt such innovative ICT tools to foster more effective and engaging learning environments, ultimately contributing to better preparation of students for the demands of Industry 4.0.

4. Conclusion

This study provides strong empirical evidence that the integration of the Kahoot! educational game significantly enhances student learning outcomes in the Engine and Heavy Equipment Unit course for Phase F students at SMK Muhammadiyah 1 Pekanbaru. Utilizing a quasi-experimental design with control and experimental groups of equal size (n=18 each), the findings demonstrate a substantial improvement in the experimental class's average scores, rising from 58.3 in the pre-test to 80.28 in the post-test. In contrast, the control group showed a smaller increase from 56.7 to 74.17. The hypothesis testing confirmed this difference was statistically significant ($t = 3.618 > t_{critical} = 2.101$), validating the effectiveness of Kahoot! as an interactive learning tool.

These results emphasize the critical role of Information and Communication Technology (ICT) in vocational education, particularly through gamified platforms that foster engagement, motivation, and active participation. The considerable increase in both average and minimum scores in the experimental group highlights Kahoot!'s capacity to support diverse learners in mastering complex technical content.

However, this study has limitations, including a relatively small and localized sample, which may affect the generalizability of the findings. Future research should explore larger, more diverse populations across multiple vocational institutions and examine long-term learning retention and affective outcomes such as student motivation and attitudes. Additionally, investigating the integration of Kahoot! with other instructional strategies could further optimize learning effectiveness.

In conclusion, the integration of gamified learning tools like Kahoot! offers promising pathways to enhance vocational education quality, aligning with the demands of Industry 4.0. This study lays the groundwork for further research to deepen understanding of technology-enhanced in vocational learning.

Author's declaration

Author contribution

Enjela Dwi Ananda contributed to the conceptualization, methodology design, data collection, and manuscript writing. **Ambiyar** was responsible for data analysis, interpretation of results, and critical revision of the manuscript. **Mahesi Agni Zaus** provided supervision, validation of findings, and guidance throughout the research process. **Sadly Firmansyah** assisted in data collection, literature review, and formatting of the manuscript. All authors have read and approved the final version of the manuscript.

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Competing interest

The authors declare that they have no competing interests related to this study.

Ethical clearance

This research was conducted in accordance with ethical principles for educational research involving human subjects. Approval was granted by the Research Ethics Committee of SMK Muhammadiyah 1 Pekanbaru. Prior to the study, informed consent was obtained from all participating students and their guardians. The confidentiality and anonymity of all participants were ensured and maintained throughout the research process.

AI statement

This manuscript was prepared solely by the authors without the use of artificial intelligence (AI) tools in the writing, data analysis, or interpretation processes. English is checked using Grammarly and has been verified by the authors.

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Universitas Negeri Padang as the publisher and Editor of Jurnal Vokasi Informatika (JAVIT) state that there is no conflict of interest towards this article publication.

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