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EXAMINING THE PRACTICALITY OF MOBILE-BASED GAMIFICATION ASSESSMENT IN ELECTRICAL MACHINE COURSE: A STUDY IN INDUSTRIAL ELECTRICAL ENGINEERING

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ABSTRACT
Mobile-based gamification learning is increasingly popular for enhancing student interest and motivation in the learning process, including its application in evaluating learning outcomes. However, the practicality of its use, from the perspective of students as users, needs further evaluation. This study aims to assess the practicality of mobile-based gamification assessment (M-BGA) in evaluating student learning outcomes in the Electrical Machine Course (EMC). M-BGA was developed using Kahoot! application. A survey-based quantitative research design was employed, using the Practicality Assessment Instrument (PAI) as the data collection tool. The practicality of M-BGA was evaluated based on student assessments after its implementation in an EMC. This research involved 83 second-year students from the Industrial Electrical Engineering Study Program, Faculty of Engineering, Universitas Negeri Padang, Indonesia. The results indicate a high level of practicality in several aspects. The Ease of Use aspect scored 92.23% (highly practical), the Reliability aspect scored 89.82% (highly practical), the Student Engagement aspect scored 88.55% (highly practical), and the Learning Impact aspect scored 90.19% (highly useful). Overall, based on student responses, the M-BGA proved to be highly practical in evaluating student learning outcomes in the EMC. M-BGA can serve as an alternative approach for assessing student learning outcomes with an innovative approach.
Keywords: *Mobile-Based Gamification Assessment, Practicality Analysis, Industrial Electrical Engineering, Electrical Machine Course.*

1. Introduction

Assessing student learning outcomes is an essential component of an effective learning process (Aguiar-Castillo et al., 2020; Chamorro-Atalaya et al., 2023; Díaz-Ramírez, 2020). In the context of the EMC, a comprehensive and accurate evaluation of students' comprehension of concepts and practical skills is crucial to ensure the achievement of learning objectives. However, traditional assessment approaches such as written tests or oral exams often lack the ability to provide an engaging learning experience and effectively motivate students (Chan et al., 2022; Sanchez et al., 2020). In recent years, advancements in mobile technology and the concept of gamification have opened up new possibilities for implementing interactive and engaging assessments, with the potential to enhance student motivation and interest in learning (de la Peña et al., 2021; Sanchez et al., 2020; Zainuddin et al., 2020). Particularly during the COVID-19 pandemic a few years ago, the utilization of mobile-based gamification in the learning process gained increasing popularity (Candra et al., 2022; de la Peña et al., 2021; Zainuddin et al., 2020).

With the advancement of technology and educational innovation, numerous studies have explored using mobile technology in education and evaluating learning outcomes (Kamaghe et al., 2020; Sajinčič et al., 2022). Previous studies have highlighted the application of mobile-based assessment and gamification approaches in higher education (Aguiar-Castillo et al., 2020; Sanchez et al., 2020). For instance, studies related to the use of mobile applications in formative and summative assessments have demonstrated the potential to boost student engagement, motivation, and interaction in the learning process(Behl et al., 2022; Sanchez et al., 2020; Zainuddin et al., 2020). Additionally, the concept of gamification, which incorporates game elements into an educational context, has successfully increased students' intrinsic motivation and active participation (Behl et al., 2022; de la Peña et al., 2021; Waskito et al., n.d.). Nevertheless, in the context of the EMC, research on the implementation of mobile-based gamification assessment remains limited, particularly regarding the evaluation of its practicality from the perspective of students as users. Meanwhile, the necessity of implementing MBGA in the learning process requires in-depth exploration to enable the optimal integration of learning and evaluation systems for student learning outcomes. Furthermore, an examination of the practicality from the perspective of students as users is crucial to ensure that gamification technology applied to the learning process genuinely supports students in their learning process. As students represent the primary focus of the learning process, their involvement in selecting and considering the technology and learning system to be applied is paramount. Therefore, this study enhances the understanding of the potential use of this approach in improving the evaluation of student learning outcomes in these courses, ultimately facilitating an optimal learning process as a whole.

The primary objective of this study is to assess the practicality level of M-BGA in evaluating student learning outcomes in the EMC. The evaluation will involve the use of practicality assessment instruments employing a Likert scale, which will be administered to students after they have utilized M-BGA during the learning process. The aim of this evaluation is to obtain a comprehensive understanding of the acceptability and practicality of this approach in the context of the EMC, based on student responses as users. Consequently, valuable recommendations can be provided for the development of learning implementation in the field of Industrial Electrical Engineering.

This research presents an original contribution to the implementation of the learning process in Industrial Electrical Engineering by integrating the M-BGA approach to evaluate student learning outcomes in the EMC. This approach has not been extensively explored in this field before, which emphasizes the uniqueness of this study. The main contribution of this research is to identify and describe the practicality of employing M-BGA as an effective evaluation tool for enhancing student learning outcomes. The findings of this study can provide valuable insights for the development and implementation of innovative evaluation strategies in the learning process of Industrial Electrical Engineering study programs, thereby fostering increased student interaction and engagement.

2. Literature Review

Mobile-based Gamification Assessment

M-BGA is an evaluation approach developed using specific gamification applications, which can be accessed through mobile devices, with the aim of increasing student interaction, motivation, and active participation in the process of evaluating learning outcomes. In this approach, game elements such as points, ratings, and challenges are applied in an educational context to create an engaging and interactive learning experience (Prott & Ebner, 2020; Vankúš, 2023). This study utilizes Kahoot! application to develop an M-BGA. The utilization of Kahoot! application in M-BGA allows for the implementation of time-limited multiple-choice questions, various forms of questions, and live scoring. Students can answer questions in real-time via their mobile devices, while the system provides instant feedback on correct answers and scores achieved. Additionally, the presence of rankings and scoreboards makes the evaluation process more competitive, encourages active student participation, and increases learning motivation.

The selection of Kahoot! as the Mobile-Based Gamification Assessment (M-BGA) platform in this research is based on several distinctive features that position it as the primary choice compared to other applications. Kahoot! is renowned for its user-friendly interface, real-time response system, and integration of gamification elements. Its highly flexible capabilities enable the creation of dynamic quizzes with time-limited questions, live scoring, as well as the incorporation of game elements such as points, rankings, and challenges (Prott & Ebner, 2020; Wirani et al., 2022). Additionally, Kahoot! provides instant feedback, ranking systems, and scoreboards, enhancing the competitive aspect of the evaluation (de la Peña et al., 2021; Prott &

Ebner, 2020). All of these attributes collectively contribute to a positive and stimulating learning experience, which is crucial and aligns with the requirements of the EMC.

The advantages of M-BGA include increased student engagement, facilitation of collaborative and competitive learning, and provision of direct feedback that can encourage improved understanding of concepts (Prott & Ebner, 2020; Sanchez et al., 2020; Vankúš, 2023). This approach also provides flexibility in terms of time and place as it can be accessed via mobile devices, enabling evaluations to be conducted outside the classroom or even independently (Sanchez et al., 2020; Zainuddin et al., 2020). In the context of the Kahoot! application, the use of M-BGA can offer an interesting and interactive evaluation experience, turning the assessment process into an enjoyable and motivating activity for students. Furthermore, electronic data collection enables more efficient and in-depth analysis of student performance, thereby providing valuable information for curriculum development and improvement of learning outcomes in the future (Palaniappan & Noor, 2022; Sajinčič et al., 2022).

Electrical Machine Course

The EMC is a fundamental component of the Industrial Electrical Engineering study program. Its objective is to provide students with a comprehensive understanding of the fundamental principles and applications of electrical machines in various sectors, including industry, energy, and transportation (Wrobel, 2022; Zhao et al., 2023). Within the context of the EMC, there are specific requirements for the application of mobile-based assessment. Firstly, an assessment is needed that accurately measures students' comprehension of the core concepts related to electric machines (Kareem & Michael, 2022; Selema et al., 2023). Mobile-based assessment should be able to evaluate students' understanding of electromagnetic principles, transformers, electric motors, and other relevant components (Candra et al., 2023; Kareem & Michael, 2022; Selema et al., 2023).

Secondly, mobile-based assessment in the EMC should provide dynamic and engaging interactions to actively involve students in the evaluation process (Petrovych et al., 2023; Sajinčič et al., 2022). Utilizing a mobile app such as Kahoot! can offer an interactive experience through time-limited multiple-choice questions, scoreboards, and instant feedback. This enhances student participation, fosters learning motivation, and creates a positive competitive environment. Lastly, mobile-based assessment in the EMC should also provide flexibility in terms of time and location (Petrovych et al., 2023; Tiismus et al., 2022). Students can access and participate in evaluations through their mobile devices at any time and from anywhere, enabling assessments to be conducted outside the classroom and facilitating independent learning. By meeting these requirements, M-BGA can be an effective tool for evaluating students' comprehension in the EMC. This approach not only enhances student engagement and learning motivation but also facilitates efficient data collection and in-depth analysis of student learning outcomes.

3. Research Methods

Research Design

This study aims to evaluate the practicality of the M-BGA application in assessing student learning outcomes in the EMC. To achieve this objective, a survey-based quantitative research design was employed (Huda et al., 2020; Petrovych et al., 2023; Yanto, Sukardi, et al., 2023). The research design involved collecting practical assessment data from students after they utilized the M-BGA during the EMC. Survey-based quantitative research is an appropriate method for obtaining descriptive insights into the evaluation or assessment of a specific variable (Aguiar-Castillo et al., 2020; Hartanto et al., 2022; Novaliendry et al., 2022). By systematically collecting information using a predetermined design, the accuracy of the obtained data and information can be ensured. This research design enables comprehensive data collection regarding the practicality of M-BGA applications used in the EMC.

Research Instrument

The Practicality Assessment Instrument (PAI) was employed as the data collection tool in this study. This instrument comprises practicality statements and response options utilizing a Likert scale, ranging from a minimum score of "1" for "Strongly Disagree" to a maximum score of "5" for "Strongly Agree". The instrument is utilized to assess participants' perceptions of the practical aspects of the M-BGA application, encompassing several variables, namely Ease of Use, Reliability, Engagement, and Learning Impact. Table 1 presents the variables and indicators included in the PAI.

Table 1 - Dimensions and Indicators of the PAI

Variables	Theoretical Framework	Indicators
Ease of Use	(Prott & Ebner, 2020; Vankúš, 2023)	EU.1. M-BGA is user-friendly for evaluating learning outcomes in the Electrical Machines course. EU.2. The M-BGA interface is intuitive and easy to comprehend. EU.3. M-BGA facilitates answering questions and completing evaluation activities effortlessly. EU.4. The navigation and functions of M-BGA are clear and straightforward. EU.5. The provided guide or instructions in M-BGA are helpful.
Reliability	(de la Peña et al., 2021; Sanchez et al., 2020; Zainuddin et al., 2020)	R.1. The evaluation results provided by M-BGA accurately reflect your knowledge and abilities in the Electrical Machines course. R.2. M-BGA consistently delivers reliable evaluation results. R.3. No technical problems or errors have been encountered while using M-BGA. R.4. M-BGA can provide a fair and objective assessment of your learning outcomes. R.5. M-BGA offers informative and useful feedback related to your evaluation results.
Student Engagement	(Behl et al., 2022; de la Peña et al., 2021; Zainuddin et al., 2020)	SE.1. You actively engage with M-BGA to evaluate your learning outcomes. SE.2. M-BGA encourages active participation in evaluation activities. SE.3. There is frequent interaction with the app during the evaluation process. SE.4. M-BGA fosters motivation to improve learning outcomes in the Electrical Machines course. SE.5. M-BGA provides an enjoyable and engaging learning experience.
Learning Impact	(Bucchiarone, 2022; de la Peña et al., 2021; Pensabe-Rodriguez et al., 2020)	LI.1. M-BGA has the potential to enhance your understanding of the Electrical Machines' material. LI.2. M-BGA helps you identify areas for improvement in your learning outcomes. LI.3. M-BGA increases your motivation to learn and participate in the Electrical Machines course. LI.4. The feedback provided by M-BGA can improve your understanding. LI.5. M-BGA helps you achieve better learning outcomes compared to traditional evaluation methods.

Participant

The participants in this study were selected using simple random sampling techniques (Prott & Ebner, 2020; Yanto, Ganefri, et al., 2023), with the sample size determined through the application of the Slovin formula (de la Peña et al., 2021; Yanto, Zaswita, et al., 2023). Given a population of 105 sophomore students, the final number of participants included 83 students. This research involved 83 sophomore students from the Industrial Electrical Engineering Study Program, Faculty of Engineering, at Universitas Negeri Padang, Indonesia. The participants in this study played a crucial role in evaluating the practicality of the M-BGA. They were tasked with completing the PAI after utilizing the M-BGA for one semester in an EMC. The assessment data collected from these students formed the primary basis for evaluating the practicality of the M-BGA.

Data Analysis Technique

Partial Least Squares (PLS) analysis was initially conducted on the research data to ensure the validity and reliability of the research instrument, specifically focusing on the indicators of all research variables (Dash & Paul, 2021; Hair & Alamer, 2022). Once all indicators were confirmed to be valid and reliable, the data were analyzed using descriptive analysis, which involved calculating percentages for each aspect of practicality (Dapica et al., 2022; Wirani et al., 2022). The findings from this analysis were then interpreted using a practicality criteria table to determine the level of practicality of the tested M-BGA applications in this study (Dapica et al., 2022; Omotosho et al., 2019). Practicality criteria are presented in Table 2. This sequential data analysis process yielded comprehensive and accurate information regarding the practicality of using the M-BGA application in the learning process of electrical engineering courses, based on student assessments and responses as users.

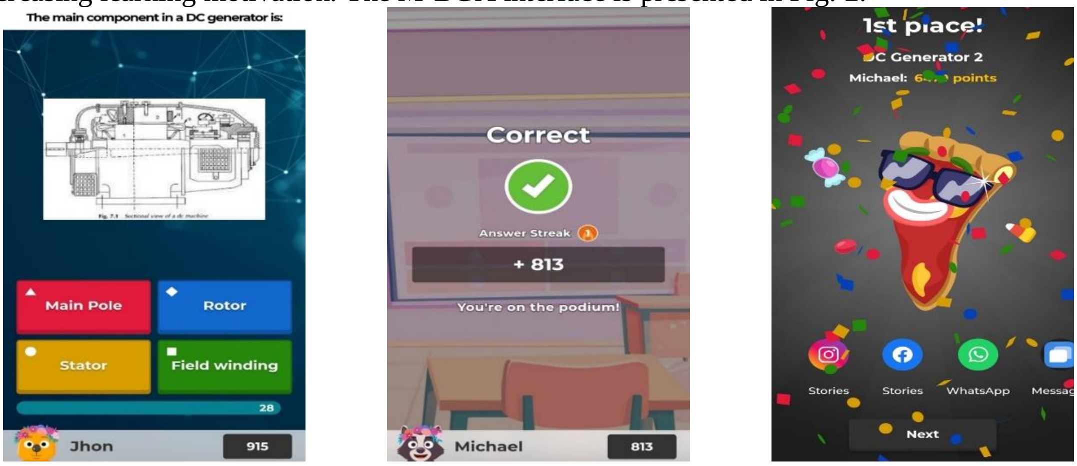
Table 2 – Practicality Criteria

No.	Practicality Score	Classification
1	81-100	Highly Practical
2	61-80	Practical
3	41-60	Moderately Practical
4	21-40	Les Practical
5	0-20	Not Practical

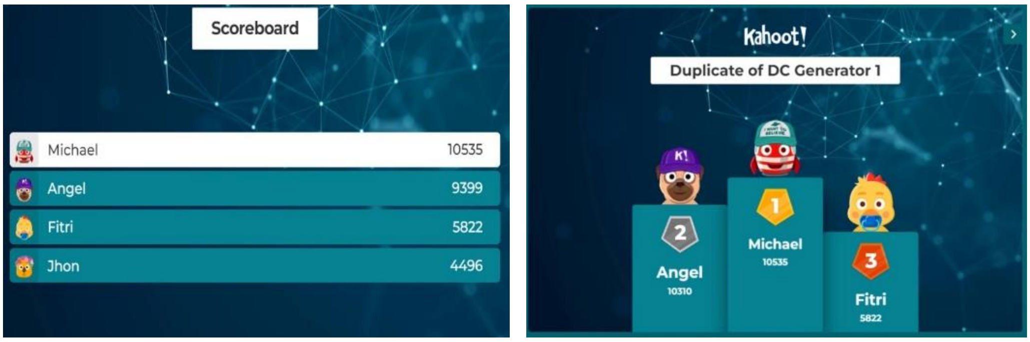
4. Results and Discussions

Mobile-Based Gamification Assessment

M-BGA is a mobile application developed using Kahoot! application, utilizing a gamification approach for learning evaluation. It can be accessed through mobile devices with the objective of enhancing student interaction, motivation, and active participation in the process of evaluating learning outcomes. M-BGA includes quizzes for each learning session, exams for each basic competency, midterm exams, and final semester exams. All assessments are designed in two question formats: multiple-choice and true/false. In this approach, game elements such as points, ratings, and challenges are incorporated within an educational context to create an engaging and interactive learning experience. Students can respond to questions in real time using their mobile devices, while the system provides immediate feedback on correct answers and achieved scores. Furthermore, the gamification approach includes the application of a ranking system and scoreboard, fostering competitiveness, encouraging active student participation, and increasing learning motivation. The M-BGA interface is presented in Fig. 2.



(a) (b) (c)



(d) (e)

Fig. 2. The M-BGA Interface on Student's Mobile: (a) Question; (b) Immediate Feedback on Correct/incorrect Answers and Achieved Scores; (c) Final Score; (d) Scoreboard & Ranking; and (e) Podium.

PLS Analysis of Research Data

After collecting the research data, it underwent PLS analysis as the initial step of the analysis. This analysis aimed to evaluate the validity, reliability, and extent to which each indicator accurately represents the variables (Dash & Paul, 2021; Yanto, Sukardi, et al., 2023; Zulfahmi et al., n.d.). However, prior to conducting the analysis, the data needed to meet certain assumptions and requirements (Candra et al., 2020; Dash & Paul, 2021; Hair & Alamer, 2022). One crucial consideration is the presence of multicollinearity issues. It is important to ensure that no multicollinearity problems exist among the indicators and variables. The Variance Inflation Factor (VIF) value serves as a reference for determining the presence of multicollinearity (Dash & Paul, 2021; Hair & Alamer, 2022; Yanto, Sukardi, et al., 2023). The analysis results of the VIF values for each indicator, presented in Table 3, indicate that all VIF values are below 5 (VIF < 5), signifying the absence of multicollinearity issues. Thus, it can be observed that the data for each indicator satisfies the necessary assumptions and analysis requirements (Dash & Paul, 2021; Yanto, Sukardi, et al., 2023).

Table 3 - The Indicator VIF Values Analysis

Indicators	VIF	Indicators	VIF	Indicators	VIF	Indicators	VIF
EU.1	1.711	R.1	1.900	SE.1	2.887	LI.1	1.590
EU.2	1.141	R.2	1.721	SE.2	2.112	LI.2	1.902
EU.3	2.772	R.3	2.990	SE.3	1.980	LI.3	1.927
EU.4	1.901	R.4	2.144	SE.4	1.873	LI.4	1.908
EU.5	1.009	R.5	1.920	SE.5	2.880	LI.5	2.006

Once it is confirmed that there are no multicollinearity issues among the indicators, the next step involves conducting an analysis of the indicators. In PLS, this analysis is referred to as Outer Model Analysis, which aims to determine item validity, convergent validity, discriminant validity, construct reliability, and unidimensional models (Dash & Paul, 2021; Yanto, Sukardi, et al., 2023). Item validity is assessed based on the outer-loading values, as presented in Table 4. It can be observed that all indicators have outer-loading values exceeding 0.7 for their respective variables. Consequently, all indicators are deemed valid in terms of item validity (Hair & Alamer, 2022; Yanto, Sukardi, et al., 2023).

Table 4 - The Outer Loading Analysis

	EU		R		SE		LI
EU.1	0.852	R.1	0.877	SE.1	0.899	LI.1	0.837
EU.2	0.819	R.2	0.891	SE.2	0.872	LI.2	0.881
EU.3	0.791	R.3	0.871	SE.3	0.836	LI.3	0.895
EU.4	0.869	R.4	0.793	SE.4	0.778	LI.4	0.776
EU.5	0.805	R.5	0.860	SE.5	0.872	LI.5	0.791

The ability of indicators to measure their respective variables is assessed through Internal Consistency Reliability (ICR), determined by Cronbach's Alpha (CA) value. Table 5 displays that the CA value for each tested variable is > 0.6, indicating the reliability of all variables (Dash & Paul, 2021; Hair & Alamer, 2022). The unidimensionality of the model (UM) test is conducted to ensure there are no measurement issues for each variable. According to Table 5, all variables meet the requirements for UM as their Composite Reliability (CR) values exceed 0.7. Moreover, with an AVE value greater than 0.50 for all variables, it signifies that all research variables are considered valid and meet the criteria for Convergent Validity (CV) (Dash & Paul, 2021; Yanto, Sukardi, et al., 2023).

Table 5 - The Results of Indicator Analysis

	CA	rho_A	CR	AVE	ICR	UM	CV
EU	0.910	0.874	0.877	0.611	Reliable	Reliable	Valid
R	0.791	0.841	0.890	0.709	Reliable	Reliable	Valid
SE	0.887	0.830	0.791	0.699	Reliable	Reliable	Valid
LI	0.895	0.811	0.813	0.684	Reliable	Reliable	Valid

Discriminant Validity (DV) can be assessed using the Fornell-Larcker Criterion, which compares the square root of AVE for each variable with the correlations between other variables in the tested path model (Hair & Alamer, 2022; Yanto, Sukardi, et al., 2023). Table 6 presents that all AVE root values for each variable are higher than the correlations between variables. Therefore, it can be concluded that all tested variables meet the criteria for DV.

Table 6 - Results of The Discriminant Validity Analysis

	EU	R	SE	LI	DV
EU	0.782				Valid
R	0.690	0.842			Valid
SE	0.587	0.567	0.818		Valid
LI	0.559	0.698	0.513	0.827	Valid

Practicality Analysis

The results of the data analysis using the practicality assessment instrument indicate that students gave an average score of 92.23% for the Ease of Use aspect. This indicates that the use of M-BGA in the EMC is considered highly practical by students in terms of ease of use. The intuitive user interface and easy navigation of M-BGA using Kahoot! facilitate students in utilizing this evaluation method. Furthermore, the analysis results also reveal that M-BGA demonstrates high reliability in evaluating student learning outcomes in the EMC. With an average score of 89.82% for the Reliability aspect, this study shows that students have a strong belief that the evaluation results obtained from this approach are reliable and accurately reflect their understanding of the subject matter. Students consider M-BGA to be highly practical when assessed from the aspect of reliability.

The analysis results also shed light on the level of student engagement in using M-BGA. With an average score of 88.55% for the Student Engagement aspect, this study demonstrates that students feel actively engaged in the evaluation process when utilizing this approach. The incorporation of interesting interactions and the use of playful elements encourage student participation, leading to an interactive and supportive learning environment. Consequently, students perceive M-BGA as highly practical when considering the active involvement of students. Moreover, M-BGA has a significant positive impact on student learning in the EMC. With an average score of 90.19% for the Learning Impact aspect, this study reveals that students reported an improvement in their understanding of the subject matter and an increase in learning motivation through the use of this approach. These results indicate that M-BGA can be an extremely practical tool for enhancing student learning outcomes. The findings from the practicality test analysis of using M-BGA to evaluate student learning outcomes in the EMC are presented in Table 7.

Table 7 - The Results of The Practicality Evaluation Analysis

Variables	Indicators	Practicality Score (%)	Average Practicality Score (%)	Practicality Level
Ease of Use	EU.1	92,75	92,23	Highly Practical
	EU.2	93,05		Highly Practical
	EU.3	90,85		Highly Practical
	EU.4	91,15		Highly Practical
	EU.5	93,35		Highly Practical
Reliability	R.1	90,15	89,82	Highly Practical
	R.2	89,9		Highly Practical
	R.3	88,16		Highly Practical
	R.4	90,14		Highly Practical
	R.5	90,73		Highly Practical
	SE.1	90,85	88,55	Highly Practical

Student Engagement	SE.2	91,77		Highly Practical
	SE.3	86,79		Highly Practical
	SE.4	87,25		Highly Practical
	SE.5	86,07		Highly Practical
Learning Impact	LI.1	90,89	90,19	Highly Practical
	LI.2	89,91		Highly Practical
	LI.3	91,21		Highly Practical
	LI.4	88,87		Highly Practical
	LI.5	90,09		Highly Practical

Overall, the analysis of the study's results confirms that the use of M-BGA is highly practical across four key aspects: Ease of Use, Reliability, Student Engagement, and Learning Impact. These findings highlight the practicality of M-BGA, as it proves to be user-friendly, reliable in assessing students' understanding, promotes active student involvement in the evaluation process, and has a perceived positive impact on learning. This research provides a solid groundwork for implementing M-BGA in the context of Electrical Engineering courses and exploring its application in other fields of engineering education.

Discussion

The findings of this study provide a comprehensive understanding of the practicality of M-BGA in evaluating student learning outcomes in the EMC. The results indicate that, according to the students involved in the research, this approach is highly practical. Remarkable scores were obtained in all aspects of the practicality evaluation, including Ease of Use, Reliability, Student Engagement, and Learning Impact. These outcomes demonstrate that students perceive M-BGA as an extremely practical tool that is easy to use and has a positive impact on their learning.

Furthermore, the study's results highlight the high practicality of M-BGA in enhancing student engagement and motivation in studying the EMC. Students responded positively to the incorporation of game elements, such as points, rankings, and challenges within this approach. The dynamic and competitive interactions offered through M-BGA, utilizing Kahoot! provide an intriguing and motivating learning experience for students. This reinforces the advantages of M-BGA in generating interest and active participation among students in the evaluation process.

The research results confirm that M-BGA is an approach with the potential to enhance the evaluation of student learning outcomes in the EMC. The practicality of this approach in measuring conceptual understanding and increasing student involvement indicates that M-BGA can be an appealing and valuable alternative in implementing learning in Industrial Electrical Engineering study programs. The implications of this research can influence the development of innovative evaluation strategies in the field of electrical engineering education, aiming to make learning and evaluation more engaging and innovative for students.

A comparison of the results of this study with previous studies reveals both interesting differences and similarities. Overall, the findings of this study support and complement previous studies that have examined the use of mobile-based assessment in higher education contexts (Chan et al., 2022; Prott & Ebner, 2020; Vankúš, 2023). In terms of practicality, this research aligns with several prior studies that have also demonstrated a high level of practicality of mobile-based assessment for evaluating learning in higher education (Aguiar-Castillo et al., 2020; Chan et al., 2022; Sanchez et al., 2020). The findings of this study are consistent with earlier research, indicating that students perceive the use of this approach as an effective evaluation tool that is user-friendly and positively impacts their learning (Chamorro-Atalaya et al., 2023; Joshi et al., 2022; Kamaghe et al., 2020).

However, the findings of this study also highlight some differences within the context of the EMC. Several prior studies have primarily focused on general or multidisciplinary courses (Aguiar-Castillo et al., 2020; Sanchez et al., 2020), whereas this research specifically investigates the utilization of mobile-based assessment in the Electrical Engineering course within the industrial electrical engineering study program. This specificity contributes to its uniqueness as it enhances our understanding of the application of this approach within a more distinct and specialized course context.

Furthermore, the incorporation of a gamification approach into mobile-based assessment represents a distinctive and innovative aspect. This addition contributes to the development of high-quality and practical mobile-based assessment methods, while also increasing student interest and engagement as active participants in the learning process. This innovative approach adds to the uniqueness of this study, further contributing to the body of knowledge in the field of mobile-based assessment in educational contexts.

Additionally, comparisons with previous studies reveal that this study offers a more in-depth examination of evaluating practicality and measuring student engagement (Chan et al., 2022; Palaniappan & Noor, 2022; Sajinčič et al., 2022). Several prior studies have primarily focused on assessing the effectiveness and impact of learning in a broader sense (Omotosho et al., 2019; Prott & Ebner, 2020; Vankúš, 2023). Hence, this study makes a valuable contribution by enriching the literature with a more comprehensive understanding of practicality and engagement within the context of M-BGA.

The findings of this research can serve as a crucial foundation for enhancing future evaluation and learning methodologies in EMC. Demonstrating the substantial practicality of MBGA, this approach can be more extensively incorporated into the curricula of EMC. The implementation of MBGA has the potential to amplify student interaction, boost learning motivation, and encourage active participation in the evaluation process. Consequently, the learning experience in EMC can evolve to be more captivating and immersive, fostering increased student engagement in the educational process.

Moreover, the adoption of gamification-based mobile applications can be considered a paradigm for enhancing the efficacy of technology in delivering engineering content. This integration is not solely directed at refining assessments but also at crafting more engaging and participative learning environments. Hence, educational institutions and instructors may contemplate the adoption of MBGA and akin technologies as integral components of their pedagogical strategies to realize more effective and compelling learning objectives in the realm of electrical machines.

The limitations of this study must also be acknowledged and compared to previous research. Despite the inclusion of a substantial sample size and the study being conducted within the context of an Electrical Engineering course, caution should be exercised when generalizing the results. Nonetheless, the findings of this study provide a valuable understanding of the practicality and student engagement in M-BGA within Electrical Engineering courses. Through comparisons with previous studies, these findings enrich and complement the existing literature, while establishing a strong foundation for the development of innovative evaluation approaches in electrical engineering education.

5. Conclusion

This study demonstrates that M-BGA exhibits a high level of practicality in evaluating student learning outcomes in the context of the Electrical Engineering course. The approach effectively enhances student learning engagement and motivation, offering an interesting and interactive evaluation experience. These findings contribute significantly to the understanding of M-BGA's utilization in electrical engineering education, highlighting its potential to improve the effective evaluation of student learning outcomes. The implications of this research support the development of innovative evaluation strategies that are engaging and beneficial for students while reinforcing the role of mobile technology in electrical engineering education.

It is important to note that this research was conducted within a specific context, focusing on particular electrical engineering courses and utilizing Kahoot! application to develop M-BGA. Therefore, generalizing the findings to other subjects or using different evaluation tools requires further investigation within diverse learning settings. Additionally, the sample size for this study was limited to 87 students from the Industrial Electrical Engineering program. Although efforts were made to ensure representativeness, these findings may not fully encompass the perspectives and experiences of all students within the broader population. Replicating the study with a larger and more diverse sample would enhance the robustness of the findings.

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