



The Effect of Gamification Using Kahoot on Students' Critical Thinking Abilities: The Role of Mediating Learning Engagement and Motivation

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Citation: Petrusly et al. (2024), The Effect Of Gamification Using Kahoot On Students' Critical Thinking Abilities: The Role Of Mediating Learning Engagement And Motivation Educational Administration: Theory And Practice, 30(5), 953-963,

Doi: 10.53555/kuev.v30i5.1524

ARTICLE INFO ABSTRACT

Gamification plays an important role in learning by bringing play elements into educational settings. One platform often used is Kahoot, the application of Kahoot in learning brings a pleasant experience for students. Many studies highlight the important role of gamification in education. However, limited studies still prove how Kahoot can improve students' critical thinking skills by involving motivation and engagement. This study investigates the effect of Kahoot gamification on students' critical thinking skills by involving motivational and engagement mediators. Three hundred twenty-nine state university students in Lombok were involved in filling out the data. Structural equation modeling (SEM) analysis was used to test the hypothesis of this study. The study's results revealed that the application of Kahoot gamification succeeded in influencing students' critical thinking skills directly and indirectly through motivational and engagement mediators. This study has important implications for improving the quality of teaching by optimizing various gamification platforms.

Keywords: gamification, critical thinking, motivation, engagement

1 INTRODUCTION

The development of digital technology has brought significant changes to various aspects of life, including the education sector. In the last few decades, digital technology has advanced rapidly and made a huge impact in transforming the way of learning and teaching. Education is no longer confined to traditional classrooms but is increasingly connected to an evolving digital world. With digital technology, access to information and knowledge becomes easier and faster. The Internet allows students and teachers to access infinite educational resources, including interactive learning materials, videos, and e-books. This development has prompted the University to adapt to change by incorporating innovative pedagogical methodologies (Janssen et al., 2019; Kalimullina et al., 2021; Mahfud et al., 2022; Sudiyatno et al., 2019).

In the digital era, increased student interaction with technology supports innovative educational strategies in higher education, such as gamification (Kapp, 2012; Nurtanto et al., 2021; Papadakis, 2021). In the last ten years, gamification has grown in popularity in teaching in higher education (Metwally et al., 2021; Murillo-Zamorano et al., 2020; Swacha, 2021). Gamification "uses game-based mechanics, aesthetics, and game thinking to engage people, motivate action, encourage learning, and solve problems" (Kapp, 2012). Gamification leverages play elements and interactive mechanics, and gamification transforms learning into a more interactive experience. Fun and interesting for students (Barber & Smutzer, 2017). In universities, gamification is used to increase student motivation and engagement in learning (Aldalur & Perez, 2023; Bilro et al., 2021; Bouchrika et al., 2019; Yildiz et al., 2021), with the ultimate goal of improving academic performance (Aguiar-Castillo et al., 2020; Rincon-Flores et al., 2022), and final grades (Ortiz-Martínez et al., 2022).

In addition, the gamification method approach also encourages problem-solving (Schöbel et al., 2022; Stoeffler et al., 2020), creativity (Aljraiwi, 2019; Chen et al., 2020), and critical thinking (Angelelli et al., 2023; Asigigan & Samur, 2021; Jodoi et al., 2021). With gamification, learning becomes a task and a fun adventure, stimulating students' interest and motivation to learn more effectively. Instilling critical thinking in students is crucial to solving their problems, especially effectively fighting misinformation (Machete & Turpin, 2020; Mahfud et al., 2017). In the twenty-first century, critical thinking is one of the most important talents for learning (National Education Association, 2010; Trilling & Fadel, 2009). Using a learning model that can educate these talents is one technique to encourage critical thinking skills in learning.

One of the gamification platforms that is often used in learning in higher education is Kahoot (Cadet, 2023; Ghawail & Yahia, 2022; Schultz et al., 2022; Wirani et al., 2022). Kahoot is an interactive platform that enables teaching through game-based quizzes. Lecturers use Kahoot to encourage student motivation and involvement in academic performance evaluation activities. However, other studies show different findings that Kahoot does not significantly improve student achievement (Leon & Peña, 2022).

Learning using Kahoot offers learning that is both challenging and fun. Kahoot's interactive quiz format allows students to think critically and find the best solutions within a limited time. Kahoot, a game-based assessment tool, encourages students to actively participate in learning through action and reflection (Cadet, 2023). Kahoot has been shown to improve student performance on exams and reduce dropout rates (Bienvenido-Huertas et al., 2023) when used as an experiential learning tool. The study's results by Cheng et al. (2020) demonstrated a substantial impact on critical thinking and self-reflection processes while measuring student development, adding to similar ideas about the usefulness of experiential learning. The Kahoot strategy encourages students to respond quickly to questions while considering the available options. Plus, live rankings and grading within Kahoot provide instant feedback to students so that they can see their progress in real-time. With Kahoot games, the learning process in tertiary institutions becomes more interesting and exciting while still encouraging students to develop their critical thinking skills in facing learning challenges.

Based on existing literature studies on gamification, it has been highlighted that gamification has an important role in improving students' critical thinking skills, and a small number show different findings. In addition, many have used Kahoot as a formative or summative evaluation to provide feedback and encourage student learning (Ismail et al., 2019). Previous studies also revealed that 90% of students approved of using Kahoot in courses because they felt it was a safe and interesting learning technique for mastering learning content (Freitas et al., 2020). Although many studies have discussed the importance of applying gamification to learning, limited studies still discuss how Kahoot affects students' critical thinking skills by involving their motivational and involvement factors. Therefore, this study seeks to fill a gap in studies investigating the effect of applying Kahoot as a gamification method to improve students' critical thinking skills by placing involvement and motivation as mediators.

2 LITERATURE REVIEW

2.1 Gamification on critical thinking

Gamification is a way to make people more interested in activities in various fields, such as science (Sørensen et al., 2016), creating habits of exercise (Hamari & Koivisto, 2015), and knowledge management (Friedrich et al., 2020). In addition, gamification also helps individuals to develop problem-solving skills and critical thinking (Angelelli et al., 2023; Legaki et al., 2020; Rojas-López et al., 2019). According to Deterding et al. (2011), gamification is when game mechanisms are used in non-game settings. Another meaning of gamification shows that gamification is the process of making something more like a game and changing people's behavior by activating their motivation. Using games correctly can make boring tasks more fun and exciting (Y. Xu, 2011). In the classroom, gamification is "a series of activities and processes for solving problems related to learning and education by using or implementing game mechanisms" (Kim et al., 2018). In principle, gamification combines the fun aspects of games with the seriousness required to solve real-world problems in-game settings (Bilgin & Gul, 2020).

The role of gamification in improving students' critical thinking skills is very important (Angelelli et al., 2023; Jodoi et al., 2021). The gamification feature combines game elements, such as challenges, prizes, and competition; gamification encourages students to think analytically, make the right decisions, and solve problems effectively (Jodoi et al., 2021; Schöbel et al., 2022; Stoeffler et al., 2020). Through solving challenging tasks, students can practice their skills in analyzing information, connecting concepts, and considering various points of view. In addition, gamification also stimulates critical thinking by providing instant feedback and opportunities to try again (Jodoi et al., 2021). Students can identify their weaknesses and strengths in the learning process and develop critical thinking skills through reflection and adjustment.

One of the gamification platforms that is often used to evaluate student academic performance is Kahoot. Kahoot is a learning platform that combines Student response systems (SRSS) and existing technical

infrastructure in schools, and students bring their own digital devices, social networks, and games (A. I. Wang & Tahir, 2020). Kahoot aims to improve learning performance and class dynamics by increasing engagement, motivation, fun, and concentration (A. I. Wang & Tahir, 2020). Boredom can lead to poor learning and bad behavior in a computer learning environment (Ortiz-Martínez et al., 2022). Kahoot is a play-based learning platform that reviews student knowledge, conducts formative assessments, or provides a break from regular classroom activities. Several studies have found that using Kahoot in the classroom can increase motivation and facilitate participation with significant effects (Baker et al., 2010). Thus, applying Kahoot gamification can improve students' critical thinking skills.

H1: Gamification has a significantly positive effect on students' critical thinking skills.

2.2 Effect of gamification on motivation and engagement

Gamification does not imply turning daily operations into games but rather revamping some activities and processes so that users enjoy and interact more with what they are doing (Wood & Reiners, 2015). The effect of gamification on increasing student motivation and learning engagement is significant (Aldalur & Perez, 2023; Donnermann et al., 2021). In education, gamification utilizes game elements to create interesting and fun student learning experiences. By implementing elements such as points, levels, challenges, and rewards, gamification can generate a spirit of competition and encouragement to achieve learning goals.

One of the important effects of gamification is increasing students' intrinsic motivation (Alt, 2023; Feng et al., 2018; J. Xu et al., 2021). By providing challenges and rewards tied to achievement in learning, gamification activates students' innate drives to seek achievement and recognition. This intrinsic motivation helps students maintain interest and enthusiasm in learning, even when facing difficulties or challenges. Self-Determination Theory (SDT), a modern theory of motivation important in gamification, postulates that a greater degree of individual self-determination behavior can positively enhance their intrinsic motivation (Ryan & Deci, 2002). Consequently, when students participate in the learning process and choose their learning route, they tend to be intrinsically motivated to learn (Gupta & Goyal, 2022). Therefore, games must be made attractive to promote a motivating and enjoyable learning experience and, as a result, achieve the desired learning outcomes (Mekler et al., 2017).

In addition, in this study, the application of Kahoot gamification significantly affects student motivation (Ismail et al., 2019) and engagement (Ghawail & Yahia, 2022). In the Kahoot feature, students feel the excitement and a competitive spirit which can increase their motivation to study. The adrenaline rush of competing with classmates, seeing the rankings on the scoreboard, and being rewarded for the highest achievement awakens a strong intrinsic passion. Kahoot gamification effectively increases student motivation and provides a fun and interactive learning experience (A. I. Wang & Tahir, 2020). Also, Kahoot can encourage student engagement (Cadet, 2023; A. I. Wang & Tahir, 2020; A. Wang & Lieberoth, 2016). Thus, the application of Kahoot gamification has a significant effect on increasing student motivation and learning engagement.

H2 = Gamification Kahoot has a significant positive effect on student learning motivation.

H3 = Gamification Kahoot has a significant positive effect on student learning engagement.

2.3 The role of mediating student motivation and engagement

Previously it was explained that gamification positively influences the formation of motivation and student learning engagement. In addition, motivation and student learning involvement can influence student learning outcomes (Christenson et al., 2012). Motivation is a psychological process that describes individual activation by internal or external stimuli that cannot be observed to perform a behavior (Yildiz et al., 2021). A student's motivation is high if he is interested in learning the material presented in class and takes the necessary steps to achieve that goal. Prensky (2001) asserts that motivation is an important factor in facilitating a successful learning experience, noting that many students find traditional school education less effective and unstimulating. In the context of this study, the use of gamification as an instructional instrument shows promising potential because of its ability to enhance not only knowledge acquisition but also the development of important cognitive abilities such as critical thinking, problem-solving, collaboration, and communication (Yildiz et al., 2021).

In addition, another mediator, namely learning engagement, according to Christenson et al. (2012), the term "learning engagement" refers to the active participation of a learner in a learning activity. The construction of learning engagement consists of three dimensions which include elements of behavioral, emotional, and cognitive functions (Christenson et al., 2012; Reeve, 2013). Behavioral engagement refers to student effort, focus, and persistence. Emotional engagement refers to the positive emotions generated during learning, while cognitive engagement refers to the learner's use of sophisticated or simple learning strategies (Reeve, 2013). In addition, learning engagement also has a link to student learning outcomes and academic progress

(Christenson et al., 2012). Thus, motivation and learning engagement can mediate gamification relationships and critical thinking skills.

H4 = Motivation has a significant positive effect on students' critical thinking skills.

H5 = Learning engagement has a significant positive effect on students' critical thinking skills.

H6 = Motivation and learning engagement mediate the relationship between gamification and students' critical thinking skills.

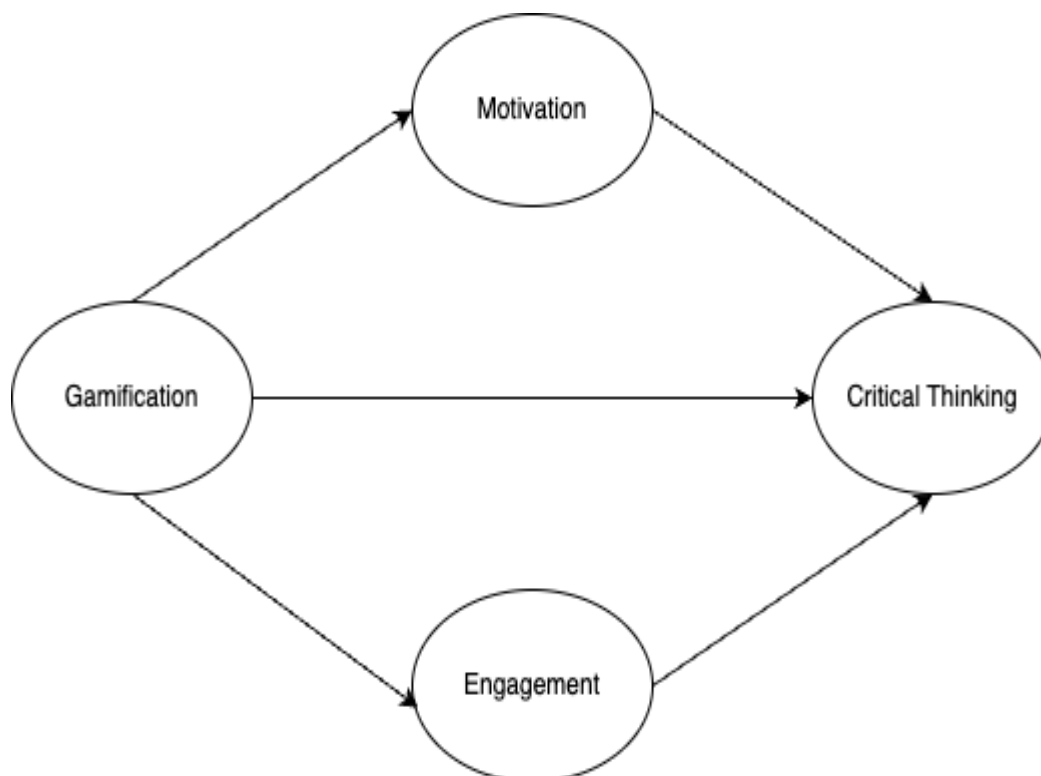


Figure 1. Research conceptual model

3 METHODS

This study included a sample of students enrolled in the Faculty of Teaching and Education at a public university in Kupang, Indonesia. A total of 329 students were enrolled in the study program, with details of 19.45% from Primary Teacher Education, 15.81% from Pancasila and Civic Education, 18.24% from Non-formal Education, 24.01% from Counseling Guidance Education, and 22.49% from Early Childhood Teacher Education. Based on gender, it consisted of 54.41% men and 45.59% women. The distribution of the characteristics of the respondents is shown in Table 1.

Table 1. Respondents' descriptive data (N=329)

Attribute	Categories	N	%
Gender	Male	179	54.41
	Female	150	45.59
Study Program	Primary Teacher Education	64	19.45
	Pancasila and Civic Education	52	15.81
	Non-formal Education	60	18.24
	Counselling Guidance Education	79	24.01
	Early Childhood Teacher Education	74	22.49

The data collection process uses an online-based self-administered questionnaire method. The students assessed their perceptions about the application of Kahoot gamification, motivation, engagement, and critical thinking. The online questionnaire was created using the Google Form platform. The entire questionnaire can be completed in approximately 15 minutes. Furthermore, we randomly distribute awards to students by providing electronic money balances, such as Gopay, OVO, or Shopee Pay.

This study uses a previous study questionnaire conducted by Aldalur & Perez (2023) and has been adapted and developed to measure student perceptions regarding the application of Kahoot gamification. This

questionnaire consists of 12 items with examples of item statements such as "The Kahoot games made the learning environment a fun and engaging one." In addition, students' perceptions of motivation to learn were collected using a previous study questionnaire (McAuley et al., 1989). The original motivational questionnaire consisted of 22 positive and negative statements. In this study, we used all 15 positive statements (e.g., Doing the task was fun). Collecting data on student learning engagement using a learning engagement questionnaire (Poondej & Lerdpornkulrat, 2016). The original questionnaire consisted of 20 items, but this study only used 12 items that best fit the context of this study (e.g., The class activities were engaging). Moreover, finally, students' perceptions of critical thinking skills were measured using a critical thinking questionnaire by Erawan (2010). This questionnaire consists of 10 items. All questionnaires for each variable use 5 Likert scales ranging from strongly agree (5) to disagree (1) strongly.

During the early stages of data analysis, we used SPSS version 20 to assess the validity and reliability of the items associated with each variable. Furthermore, SEM (Structural Equation Modeling) analysis is used with the Amos 18 software for model and hypothesis testing purposes. In the early stages, a study was conducted to assess the adequacy of the fit model by referring to the relevant model criteria (Hair et al., 2010; Phedazur, 1997). In addition, the research hypothesis was investigated by testing the acquisition of p-value on the regression path, with a significance level of 0.05. In hypothesis testing, the hypothesis is rejected if the p-value is greater than 0.05 and accepted when the p-value is less than 0.05. This study uses the bootstrapping confidence interval technique to test the significance of motivational mediators and learning engagement in the proposed model. This study used 200 bootstrap samples, each of which was used to estimate the desired parameters with a 90% confidence level.

4 RESULT

4.1 Questionnaire validity and reliability

Table 2 displays the results of the item validity test for each variable. The validity of the items in each questionnaire was assessed using the Pearson Product Moment test, which was carried out with the help of SPSS 22 software. Table 2 displays the Pearson correlation scores for all items, which include gamification, engagement, motivation, and critical thinking. This correlation score ranges from 0.341 to 0.768. This finding indicates that all items in the questionnaire have been considered valid. Furthermore, this study used Cronbach's Alpha Reliability test to assess the reliability of the questionnaire. The results of this study provide evidence that supports the reliability of the questionnaire (Cronbach's Alpha > 0.60) in assessing study variables which include gamification, engagement, motivation, and critical thinking (Hair et al., 2010).

Table 2. Validity and reliability test results

Variables	Validity	Reliability
Gamification (12 items)	0.524** ~ 0.716**	0.853
Engagement (12 items)	0.341** ~ 0.717**	0.810
Motivation (15 items)	0.553** ~ 0.768**	0.909
Critical Thinking (10 items)	0.519** ~ 0.656**	0.788

note. ** Correlation is significant at the 0.01 level (2-tailed).

4.2 Correlations between the study variables

Bivariate correlations between the various study variables are presented in Table 4. The expected positive direction of correlation was found between the study variables. Correlation strength is divided into strong, medium, and low correlation (Blakstad, 2008). Table 4 shows a strong correlation (> 0.500) between gamification and the other three factors: engagement, motivation, and critical thinking. In addition, a strong relationship is also shown in the relationship between critical thinking and the two mediator factors, namely engagement and motivation. Meanwhile, the correlation between motivation and engagement shows a moderate relationship (0.300 0.500). Furthermore, there is no low relationship between the variables of this study.

Table 3. Bivariate Pearson correlation coefficients

	Gamification	Engagement	Motivation	Critical Thinking
Gamification	1.000			
Engagement	.710	1.000		
Motivation	.677	.481	1.000	
Critical Thinking	.642	.600	.644	1.000

4.3 Structural Equation Modeling Analysis

Figure 2 displays the regression results between variables, including student gamification, engagement, motivation, and critical thinking. The first step before testing the hypothesis is to test the fit model, and the study results revealed that the study model met the fit model criteria with a value of $cmin/df = 4.08$, $RMSEA = 0.063$, $CFI = 0.890$, $GFI = 0.901$, $TLI = 0.930$, $AGFI = 0.895$, and $RMR = 0.044$.

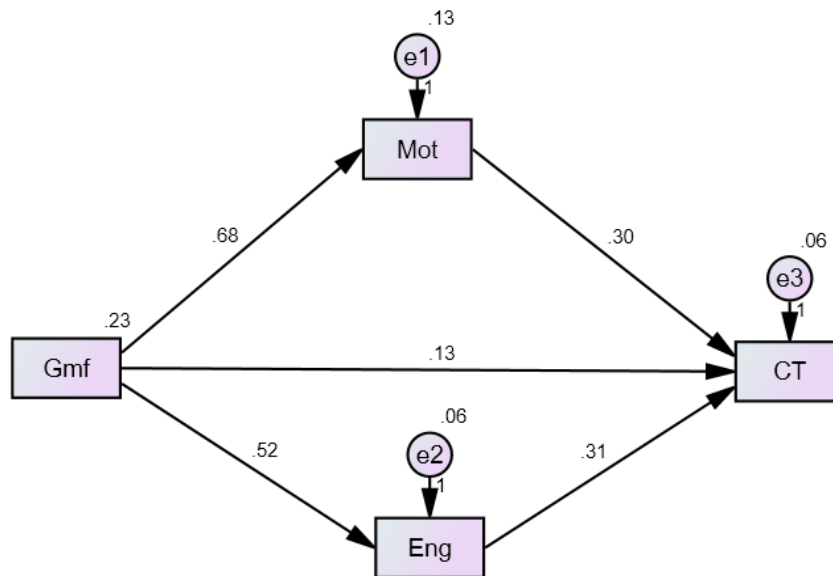


Figure 2. SEM analysis results

Note: Gmf= gamification; Mot= motivation; Eng=engagement; CT= critical thinking

The hypothesis testing carried out in this study uses the assumption of accepting the null hypothesis if the p-value criterion is less than 0.05. Table 3 presents the results of structural equation model (SEM) analysis applied to path analysis, specifically focusing on examining direct effects. Empirically, Kahoot gamification has a significant effect on engagement (estimate= 0.710; p-value= ***; the third hypothesis is accepted), motivation (estimate= 0.677; p-value= ***; the second hypothesis is accepted), and critical students' thinking (estimate= 0.173; p-value= 0.003; the first hypothesis is accepted).

In addition, testing the fourth hypothesis shows an estimated value of 0.386 (p-value = ***). This finding shows that the fourth hypothesis is accepted and means that motivation significantly positively affects students' critical thinking skills. Students' critical thinking skills are also influenced by their learning engagement in learning (estimate = 0.292; p-value = ***; the fifth hypothesis is accepted).

Table 3. The results of the path analysis among variables (standardized regression weights)

Path	Estimate	S.E.	C.R.	P	Label
Gmf ---> Mot	0.677	0.041	16.678	***	par_1
Gmf ---> Eng	0.710	0.029	18.248	***	par_2
Gmf ---> CT	0.173	0.045	2.976	0.003	par_3
Mot ---> CT	0.386	0.042	7.087	***	par_4
Eng ---> CT	0.292	0.06	5.125	***	par_5

Note. *** = Correlation is significant at the 0.001 level; Gmf= gamification; Mot = motivation; Eng= engagement; CT= critical thinking

In addition, this study examines the indirect impact of the independent variables on the dependent variable. Motivation and engagement in this study act as moderating variables on gamification relationships and students' critical thinking skills. This study uses the bootstrapping estimation method to calculate the confidence interval, with 200 samples and a 90% confidence level, to assess the significance of the role of the mediator. The results of the analysis of the role of mediators are shown in Table 4. The study revealed that motivation and engagement significantly mediated the gamification relationship and students' critical thinking skills. This is evidenced by acquiring an estimated value of 0.469 and a p-value of 0.004 (the sixth hypothesis is accepted).

Table 4. Structural routes and indirect effect (standardized regression weights)

Path Structure	Estimate	LB	UB	P
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Gmf → Mot + Eng → CT	0.469	0.380	0.573	0.004
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Note. Gmf= gamification; Mot = motivation; Eng= engagement; CT= critical thinking

5 DISCUSSION

Scholars have highlighted the importance of gamification in learning, especially for its role in improving students' critical thinking skills. One of the gamifications often used is Kahoot which offers interactive and competitive learning activities and encourages students to use critical thinking skills in solving problems and making decisions quickly. KAHOOT presents challenges and questions that require analytical, evaluative, and creative thinking. Many studies have discussed the importance of applying gamification to learning. However, limited studies still discuss how Kahoot affects students' critical thinking skills by involving their motivational and involvement factors. Therefore, this study examines the role of applying Kahoot as a gamification method to improve students' critical thinking skills by placing involvement and motivation as mediators.

In testing the first hypothesis, it has been proven that gamification significantly affects students' critical thinking skills. The results of this study are relevant to previous studies, which state that the application of gamification has encouraged students to think critically and solve problems (Jodoi et al., 2021; Schöbel et al., 2022; Stoeffler et al., 2020). The type of gamification used in the context of this study is Kahoot. The application of Kahoot has a significant effect on growing students' critical thinking skills. Kahoot can improve learning performance and class dynamics by increasing engagement, motivation, fun, and concentration (A. I. Wang & Tahir, 2020). Kahoot, a game-based interactive platform, encourages students to be actively involved in learning. Through the questions posed in Kahoot, students face situations requiring critical thinking to analyze, evaluate and solve problems quickly. They must choose the right answer and make rational decisions within a limited time. In addition, Kahoot also provides instant feedback, allowing students to reflect on their understanding and improve their critical thinking skills as the game progresses. Thus, Kahoot is important in training students' critical thinking skills through challenging and interactive learning experiences.

Other study findings prove that Kahoot gamification significantly positively affects student learning motivation and engagement (second and third hypotheses). The results of this study corroborate previous studies, which show that gamification has an important role in increasing student learning motivation and engagement (Aldalur & Perez, 2023; Donnermann et al., 2021). The application of gamification through Kahoot has effectively encouraged student learning motivation and engagement. By leveraging game elements such as points, awards, and competitions, Kahoot creates an interesting and fun learning experience for students. Students feel motivated to participate actively, try to achieve the highest achievement, and get recognition through rankings and awards. In addition, Kahoot's interactive features, such as time-limited questions and direct competition between students, also increase their learning engagement. Students feel directly involved, actively think, and make decisions quickly to achieve better results. Thus, applying gamification through Kahoot has proven its success in motivating students and increasing their involvement in the learning process.

In testing the fourth hypothesis, it reveals that learning motivation formed from applying Kahoot gamification has a significant positive effect on students' critical thinking skills. As with motivation theory, motivation is a psychological process that describes individual activation by internal or external stimuli that cannot be observed to perform a behavior (Yildiz et al., 2021). This means that student learning motivation that is formed through the application of Kahoot gamification will encourage the formation of student behavior, for example, their critical thinking skills. This high motivation directly affects the development of students' thinking skills (Averkieva et al., 2015; Fahim & Hajimaghsodi, 2014). In addition, the findings of this study also prove that learning engagement has a significant positive effect on students' critical thinking skills, as previous studies stated that learning engagement is also linked to student learning outcomes and academic progress (Christenson et al., 2012). Learning outcomes in the form of critical thinking skills are potentially influenced by student learning engagement obtained from the encouragement of Kahoot gamification implementation.

The final finding of this study is that motivation and learning engagement mediate the relationship between gamification and students' critical thinking skills. The psychological processes obtained from Kahoot gamification will shape student motivation and ultimately influence successful learning experiences (Prensky, 2001). When gamification is applied, Kahoot game elements encourage students' intrinsic and extrinsic motivation to be actively involved in learning. This motivation encourages them to actively participate in activities that involve critical thinking, such as analyzing, evaluating, and solving problems. In addition, through gamification, high learning engagement is created, where students feel emotionally and mentally involved in learning activities. They feel challenged and excited and have a sense of ownership of the learning process. Under these conditions, motivation and learning engagement link gamification and the development of critical thinking skills (Christenson et al., 2012). High motivation and strong learning engagement facilitate students in continuously practicing and honing critical thinking skills, thereby enabling the development and improvement of better critical thinking skills. Thus, motivation and learning engagement act as important

mediators in linking the positive effects of gamification with the development of students' critical thinking skills.

6 CONCLUSION

Overall, gamification through Kahoot is very important in increasing students' motivation, learning engagement, and critical thinking skills. Using game elements in Kahoot, such as points, awards, and competitions, encourages students to actively participate in the learning process. Another finding is that students' critical thinking skills are directly influenced by their motivation and learning engagement. Motivation and student learning engagement can significantly mediate the relationship between gamification and students' critical thinking skills. The results of this study provide important implications for educational practitioners to be able to apply gamification technology in their teaching process.

This study has several limitations; first, the research focus is limited to the effect of implementing Kahoot as a gamification platform, so the generalization of the findings may be limited to the context of the gamification. Other factors, such as student background, learning styles, and individual preferences, can also affect the research results. Therefore, future research can broaden the scope by considering variations of gamification platforms and considering different contextual factors. The recommendation for further research is to conduct a longitudinal study involving long-term observations of the effect of Kahoot gamification on motivation, learning engagement, and the development of student's critical thinking skills. This will provide a deeper understanding of the long-term impact of gamification on learning and how critical thinking skills develop over time. In addition, research can explore more specific gamification strategies, including question types, difficulty levels, or other play elements that can enhance critical thinking skills more effectively. With further research, gamification in education can continue to be optimized to increase students' motivation, learning engagement, and critical thinking skills.

7 REFERENCE

- Aguiar-Castillo, L., Clavijo-Rodriguez, A., Hernández-López, L., De Saa-Pérez, P., & Pérez-Jiménez, R. (2020). Gamification and deep learning approaches in higher education. *Journal of Hospitality, Leisure, Sport & Tourism Education*, 100290. <https://doi.org/https://doi.org/10.1016/j.jhlste.2020.100290>
- Aldalur, I., & Perez, A. (2023). Gamification and discovery learning: Motivating and involving students in the learning process. *Heliyon*, 9(1), e13135. <https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e13135>
- Aljraiwi, S. (2019). Effectiveness of Gamification of Web-Based Learning in Improving Academic Achievement and Creative Thinking among Primary School Students. *International Journal of Education and Practice*, 7(3), 242–257. <https://eric.ed.gov/?id=EJ1239163>
- Alt, D. (2023). Assessing the benefits of gamification in mathematics for student gameful experience and gaming motivation. *Computers & Education*, 200, 104806. <https://doi.org/https://doi.org/10.1016/j.compedu.2023.104806>
- Angelelli, C. V., Ribeiro, G. M. de C., Severino, M. R., Johnstone, E., Borzenkova, G., & da Silva, D. C. O. (2023). Developing critical thinking skills through gamification. *Thinking Skills and Creativity*, 49, 101354. <https://doi.org/https://doi.org/10.1016/j.tsc.2023.101354>
- Asigigan, S. I., & Samur, Y. (2021). The Effect of Gamified STEM Practices on Students' Intrinsic Motivation, Critical Thinking Disposition Levels, and Perception of Problem-Solving Skills. *International Journal of Education in Mathematics, Science and Technology*, 9(2), 332–352. <https://eric.ed.gov/?id=EJ1293148>
- Averkiva, L., Chayka, Y., & Glushkov, S. (2015). Web Quest as a Tool for Increasing Students' Motivation and Critical Thinking Development. *Procedia - Social and Behavioral Sciences*, 206, 137–140. <https://doi.org/https://doi.org/10.1016/j.sbspro.2015.10.042>
- Baker, R. S. J. d., D'Mello, S. K., Rodrigo, M. M. T., & Graesser, A. C. (2010). Better to be frustrated than bored: The incidence, persistence, and impact of learners' cognitive-affective states during interactions with three different computer-based learning environments. *International Journal of Human-Computer Studies*, 68(4), 223–241. <https://doi.org/https://doi.org/10.1016/j.ijhcs.2009.12.003>
- Barber, C., & Smutzer, K. (2017). Leveling for success: Gamification in IS education. *Twenty-Third Americas Conference on Information Systems*.
- Bienvenido-Huertas, D., Rubio-Bellido, C., & León-Muñoz, M. Á. (2023). Analysis of the effectiveness of using Kahoot! in university degrees in building engineering. *Journal of Technology and Science Education*, 13(1), 288–300. <https://doi.org/https://doi.org/10.3926/jotse.1984>
- Bilgin, C. U., & Gul, A. (2020). Investigating the Effectiveness of Gamification on Group Cohesion, Attitude, and Academic Achievement in Collaborative Learning Environments. *TechTrends*, 64(1), 124–136. <https://doi.org/10.1007/s11528-019-00442-x>

- Bilro, R. G., Loureiro, S. M. C., & Angelino, F. J. de A. (2021). The Role of Creative Communications and Gamification in Student Engagement in Higher Education: A Sentiment Analysis Approach. *Journal of Creative Communications, 17*(1), 7–21. <https://doi.org/10.1177/0973258621992644>
- Blakstad. (2008). *Statistics Tutorial*.
- Bouchrika, I., Harrati, N., Wanick, V., & Wills, G. (2019). Exploring the impact of gamification on student engagement and involvement with e-learning systems. *Interactive Learning Environments, 1–14*. <https://doi.org/10.1080/10494820.2019.1623267>
- Cadet, M. J. (2023). Application of game-based online learning platform: Kahoot a formative evaluation tool to assess learning. *Teaching and Learning in Nursing, 18*(3), 419–422. <https://doi.org/https://doi.org/10.1016/j.teln.2023.03.009>
- Chen, P.-Z., Chang, T.-C., & Wu, C.-L. (2020). Effects of gamified classroom management on the divergent thinking and creative tendency of elementary students. *Thinking Skills and Creativity, 36*, 100664. <https://doi.org/https://doi.org/10.1016/j.tsc.2020.100664>
- Cheng, Y.-C., Huang, L.-C., Yang, C.-H., & Chang, H.-C. (2020). Experiential Learning Program to Strengthen Self-Reflection and Critical Thinking in Freshmen Nursing Students during COVID-19: A Quasi-Experimental Study. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 15). <https://doi.org/10.3390/ijerph1715442>
- Christenson, S. L., Reschly, A. L., & Wylie, C. (2012). Handbook of research on student engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement*. Springer US. <https://doi.org/https://doi.org/10.1007/978-1-4614-2018-7>
- Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining “gamification. *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*.
- Donnermann, M., Lein, M., Messingschlager, T., Riedmann, A., Schaper, P., Steinhäusser, S., & Lugin, B. (2021). Social robots and gamification for technology supported learning: An empirical study on engagement and motivation. *Computers in Human Behavior, 121*, 106792. <https://doi.org/https://doi.org/10.1016/j.chb.2021.106792>
- Erawan, P. (2010). Developing life skills scale for high school students through mixed methods research. *European Journal of Scientific Research, 47*(2), 169–186.
- Fahim, M., & Hajimaghsoodi, A. (2014). The relationship between motivation and critical thinking ability of Iranian EFL learners. *International Journal of Language Learning and Applied Linguistics World, 5*(2), 454–464.
- Feng, Y., Jonathan Ye, H., Yu, Y., Yang, C., & Cui, T. (2018). Gamification artifacts and crowdsourcing participation: Examining the mediating role of intrinsic motivations. *Computers in Human Behavior, 81*, 124–136. <https://doi.org/https://doi.org/10.1016/j.chb.2017.12.018>
- Freitas, F., Scafuri, A., Scafuri, M., Teixeira, C., Silva, I., Lucena, J., Neto, J., & Cerqueira, G. (2020). Kahoot as a tool in the anatomy teaching and learning process: Teaching gamefication. *The FASEB Journal, 34*, 1. <https://doi.org/10.1096/fasebj.2020.34.s1.09901>
- Friedrich, J., Becker, M., Kramer, F., Wirth, M., & Schneider, M. (2020). Incentive design and gamification for knowledge management. *Journal of Business Research, 106*, 341–352. <https://doi.org/https://doi.org/10.1016/j.jbusres.2019.02.009>
- Ghawal, E. A. Al, & Yahia, S. Ben. (2022). Using the E-Learning Gamification Tool Kahoot! to Learn Chemistry Principles in the Classroom. *Procedia Computer Science, 207*, 2667–2676. <https://doi.org/https://doi.org/10.1016/j.procs.2022.09.325>
- Gupta, P., & Goyal, P. (2022). Is game-based pedagogy just a fad? A self-determination theory approach to gamification in higher education. *International Journal of Educational Management, 36*(3), 341–356. <https://doi.org/10.1108/IJEM-04-2021-0126>
- Hair, J., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective* (7th.). Pearson Prentice Hall.
- Hamari, J., & Koivisto, J. (2015). “Working out for likes”: An empirical study on social influence in exercise gamification. *Computers in Human Behavior, 50*, 333–347. <https://doi.org/https://doi.org/10.1016/j.chb.2015.04.018>
- Ismail, M. A.-A., Ahmad, A., Mohammad, J. A.-M., Fakri, N. M. R. M., Nor, M. Z. M., & Pa, M. N. M. (2019). Using Kahoot! as a formative assessment tool in medical education: a phenomenological study. *BMC Medical Education, 19*(1), 230. <https://doi.org/10.1186/s12909-019-1658-z>
- Janssen, N., Knoef, M., & Lazonder, A. W. (2019). Technological and pedagogical support for pre-service teachers’ lesson planning. *Technology, Pedagogy and Education, 28*(1), 115–128. <https://doi.org/10.1080/1475939X.2019.1569554>
- Jodoi, K., Takenaka, N., Uchida, S., Nakagawa, S., & Inoue, N. (2021). Developing an active-learning app to improve critical thinking: item selection and gamification effects. *Heliyon, 7*(11), e08256. <https://doi.org/https://doi.org/10.1016/j.heliyon.2021.e08256>
- Kalimullina, O., Tarman, B., & Stepanova, I. (2021). Education in the Context of Digitalization and Culture: Evolution of the Teacher’s Role, Pre-Pandemic Overview. *Journal of Ethnic and Cultural Studies, 8*(1),

- 226–238. <https://www.jstor.org/stable/48710281>
- Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. John Wiley & Sons.
- Kim, S., Song, K., Lockee, B., & Burton, J. (2018). *Gamification in Learning and Education Enjoy Learning Like Gaming* (S. I. Publishing (ed.)).
- Legaki, N.-Z., Xi, N., Hamari, J., Karpouzis, K., & Assimakopoulos, V. (2020). The effect of challenge-based gamification on learning: An experiment in the context of statistics education. *International Journal of Human-Computer Studies*, 144, 102496. <https://doi.org/https://doi.org/10.1016/j.ijhcs.2020.102496>
- Leon, A., & Peña, M. (2022). Gamification tools in the learning of shipbuilding in the undergraduate marine engineering education. *Computer Applications in Engineering Education*, 30(2), 458–471. <https://doi.org/https://doi.org/10.1002/cae.22465>
- Machete, P., & Turpin, M. (2020). The Use of Critical Thinking to Identify Fake News: A Systematic Literature Review. In M. Hattingh, M. Matthee, H. Smuts, I. Pappas, Y. K. Dwivedi, & M. Mäntymäki (Eds.), *Responsible Design, Implementation and Use of Information and Communication Technology* (pp. 235–246). Springer International Publishing.
- Mahfud, T., Kusuma, B. J., & Mulyani, Y. (2017). Soft skill competency map for the apprenticeship programme in the Indonesian balikpapan hospitality industry. *Journal of Technical Education and Training*, 9(2), 16–134. <https://publisher.uthm.edu.my/ojs/index.php/JTET/article/view/1860>
- Mahfud, T., Mulyani, Y., Setyawati, R., & Kholifah, N. (2022). The influence of teaching quality, social support, and career self-efficacy on the career adaptability skills: Evidence from a polytechnic in Indonesia. *Integration of Education*, 26(1), 27–41. <https://doi.org/https://doi.org/10.15507/1991-9468.106.026.202201.027-041>
- McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: a confirmatory factor analysis. *Research Quarterly for Exercise and Sport*, 60(1), 48–58. <https://doi.org/10.1080/02701367.1989.10607413>
- Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior*, 71, 525–534. <https://doi.org/https://doi.org/10.1016/j.chb.2015.08.048>
- Metwally, A. H. S., Nacke, L. E., Chang, M., Wang, Y., & Yousef, A. M. F. (2021). Revealing the hotspots of educational gamification: An umbrella review. *International Journal of Educational Research*, 109, 101832. <https://doi.org/https://doi.org/10.1016/j.ijer.2021.101832>
- Murillo-Zamorano, L. R., Ángel López Sánchez, J., & Bueno Muñoz, C. (2020). Gamified crowdsourcing in higher education: A theoretical framework and a case study. *Thinking Skills and Creativity*, 36, 100645. <https://doi.org/https://doi.org/10.1016/j.tsc.2020.100645>
- National Education Association. (2010). *Preparing 21st Century Students for a Global Society: An Educator's Guide to the "Four Cs."* NEA. <http://www.nea.org/assets/docs/A-Guide-to-Four-Cs.pdf>
- Nurtanto, M., Kholifah, N., Ahdhianto, E., Samsudin, A., & Isnantyo, F. D. (2021). A review of gamification impact on student behavioral and learning outcomes. *International Journal of Interactive Mobile Technologies*, 15(21), 22–36. <https://doi.org/https://doi.org/10.3991/ijim.v15i21.24381>
- Ortiz-Martínez, E., Santos-Jaén, J.-M., & Palacios-Manzano, M. (2022). Games in the classroom? Analysis of their effects on financial accounting marks in higher education. *The International Journal of Management Education*, 20(1), 100584. <https://doi.org/https://doi.org/10.1016/j.ijme.2021.100584>
- Papadakis, S. (2021). Gamification in science education: A systematic review of the literature. *Education Sciences*, 11(1), 1–36. <https://doi.org/https://doi.org/10.3390/educsci11010022>
- Phedazur, E. J. (1997). *Multiple regression in behavioral research*. Thomson Learning.
- Poondej, C., & Lerdpornkulrat, T. (2016). *The development of gamified learning activities to increase student engagement in learning*. 31.
- Premsky, M. (2001). *Digital natives, digital immigrants*. From On the Horizon MCB University Press. <https://www.marcprensky.com/writing/Premsky - Digital Natives, Digital Immigrants - Part1.pdf>
- Reeve, J. (2013). How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. *Journal of Educational Psychology*, 105(3), 579–595. <https://doi.org/10.1037/a0032690>
- Rincon-Flores, E. G., Mena, J., & López-Camacho, E. (2022). Gamification as a Teaching Method to Improve Performance and Motivation in Tertiary Education during COVID-19: A Research Study from Mexico. In *Education Sciences* (Vol. 12, Issue 1). <https://doi.org/10.3390/educsci12010049>
- Rojas-López, A., Rincón-Flores, E. G., Mena, J., García-Peñalvo, F. J., & Ramírez-Montoya, M. S. (2019). Engagement in the course of programming in higher education through the use of gamification. *Universal Access in the Information Society*, 18(3), 583–597. <https://doi.org/10.1007/s10209-019-00680-z>
- Ryan, R. M., & Deci, E. L. (2002). Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3–33). University of Rochester Press.
- Schöbel, S. M., Janson, A., & Leimeister, J. M. (2022). Gamifying Online Training in Management Education

- to Support Emotional Engagement and Problem-solving Skills. *Journal of Management Education*, 47(2), 166–203. <https://doi.org/10.1177/10525629221123287>
- Schultz, K., Klein, M., Sucharew, H., McDonald, J., DeBlasio, D., Cooperstein, E., Poynter, S., Huggins, J., & Real, F. J. (2022). The Impact of a Gamified Curriculum Using Kahoot! on Musculoskeletal Knowledge and Skill Acquisition Among Pediatric Residents. *Academic Pediatrics*, 22(8), 1265–1270. <https://doi.org/https://doi.org/10.1016/j.acap.2022.02.003>
- Sørensen, J. J. W. H., Pedersen, M. K., Munch, M., Haikka, P., Jensen, J. H., Planke, T., Andreasen, M. G., Gajdacz, M., Mølmer, K., Lieberoth, A., & Sherson, J. F. (2016). Exploring the quantum speed limit with computer games. *Nature*, 532(7598), 210–213. <https://doi.org/10.1038/nature17620>
- Stoeffler, K., Rosen, Y., Bolsinova, M., & von Davier, A. A. (2020). Gamified performance assessment of collaborative problem solving skills. *Computers in Human Behavior*, 104, 106036. <https://doi.org/https://doi.org/10.1016/j.chb.2019.05.033>
- Sudiyatno, Wu, M., Budiman, A., Purwantoro, D., Mahfud, T., & Siswanto, I. (2019). The effect of instructional quality on vocational students' academic achievement and career optimism. *International Journal of Innovation, Creativity and Change*, 7(10), 244–260. https://www.ijicc.net/images/vol7iss10/71023_Sudiyanto_2019_E_R.pdf
- Swacha, J. (2021). State of Research on Gamification in Education: A Bibliometric Survey. In *Education Sciences* (Vol. 11, Issue 2). <https://doi.org/10.3390/educsci11020069>
- Trilling, B., & Fadel, C. (2009). *Century skills*. Jossey-Bass.
- Wang, A. I., & Tahir, R. (2020). The effect of using Kahoot! for learning – A literature review. *Computers & Education*, 149, 103818. <https://doi.org/https://doi.org/10.1016/j.compedu.2020.103818>
- Wang, A., & Lieberoth, A. (2016). *The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot!*
- Wirani, Y., Nabarian, T., & Romadhon, M. S. (2022). Evaluation of continued use on Kahoot! as a gamification-based learning platform from the perspective of Indonesia students. *Procedia Computer Science*, 197, 545–556. <https://doi.org/https://doi.org/10.1016/j.procs.2021.12.172>
- Wood, L. C., & Reiners, T. (2015). Gamification. In *Encyclopedia of Information Science and Technology* (3rd ed., pp. 3039–3047). Information Science Reference.
- Xu, J., Lio, A., Dhaliwal, H., Andrei, S., Balakrishnan, S., Nagani, U., & Samadder, S. (2021). Psychological interventions of virtual gamification within academic intrinsic motivation: A systematic review. *Journal of Affective Disorders*, 293, 444–465. <https://doi.org/https://doi.org/10.1016/j.jad.2021.06.070>
- Xu, Y. (2011). Literature Review on Web Application Gamification and Analytics. *CSDL Technical Report*.
- Yildiz, İ., Topçu, E., & Kaymakci, S. (2021). The effect of gamification on motivation in the education of pre-service social studies teachers. *Thinking Skills and Creativity*, 42, 100907. <https://doi.org/https://doi.org/10.1016/j.tsc.2021.100907>