

RESEARCH ARTICLE

Investigating the impact of mobile interaction gamification on 4C skills: Perspective from student at vocational higher education in Indonesia

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Abstract: The realm of education has a highly significant impact on advancing civilization in a country. Various factors have been studied and proven to enhance different skills in the educational sector, including gamification aspects. The popularity of gamification has become a trend as a tool to create an engaging learning environment for students. Students show high interest and engagement when a subject is associated with gamification. While many studies have examined 21st-century skills, precisely the 4C skills of critical thinking, creative thinking, communication, and collaboration, few have yet to explore their connection with gamification, especially in higher education in Indonesia. This study aims to investigate students' opinions about the effects of gamification on 4C skills. The method involved an investigation through questionnaires with 105 students, comprising 25 questions on a 5-point Likert scale, and structured interviews with students meeting specific criteria. The findings indicate that several aspects of the 4C skills strongly relate to students' gaming habits, particularly critical thinking and creative thinking skills. However, gaming habits have a meagre impact on communication and collaboration skills, suggesting that not all components of the 4C skills can be enhanced through gamification. In addition, most of the 4C skills, critical thinking, creative thinking, communication, and collaboration, could see enhanced effectiveness through targeted strategies and practices. Further studies are recommended to explore using practical materials in several courses to test gamification through evaluations or other learning media.

Keywords: gamification, vocational higher education, educational technology, Indonesia

1 Introduction

Recent developments in teaching methods have become highly varied, encompassing both pedagogical approaches and technical media usage (Papadakis et al., 2020). Several studies have been conducted to examine the impact of these methods on college students (Vidakis et al., 2019). However, only some researchers have explored the use of gamification media in higher education in Indonesia. According to UNESCO (Torres-Toukoumidis & Maeöts, 2019) data from 2022, learning using gamification tools can increase children's creative opportunities. The shift towards education for an informed society requires approaches that enhance individuals' awareness to equip themselves with critical thinking skills, future planning, and decision-making.

Using devices among college students is mandatory, as several courses use online and offline blended learning methods (Figueras-Maz et al., 2017; Gikas & Grant, 2013; Moreira et al., 2017). Most students are highly dependent on smart devices. Educators in higher education leverage this dependency to engage students in learning using their devices. Based on a study by Kaur et al. (Muskhir et al., 2023), implementing gamification tools in learning can positively impact student learning outcomes.

In recent years, gamification has become a trend in the educational world, as highlighted by several studies (Kumari & Gujral, 2023; Sanchez et al., 2020). This trend has positively affected students' motivation, interaction, engagement, and social impact. Several elements in gamification systems, such as rewards, badges, achievements, and feedback, have been adapted

for online learning. There still needs to be studies on the impact of gamification on 21st-century skills, emphasizing the need for more comprehensive research focused on the relationship between gamification and 4C skills in higher education in Indonesia. By addressing these points, the introduction can offer a more complete and engaging foundation for the study, clearly highlighting the importance of exploring how gamification can enhance these crucial skills.

Gamification is widely utilized in the industrial sector for human resource management purposes, such as employee training, recruitment, performance evaluation, and organizational performance enhancement (Papadakis & Kalogiannakis, 2019; 2020). This is closely related to the soft skills required in the industrial world, such as the 4C skills. Based on the literature, what distinguishes games from gamification is that games are systems that challenge players to achieve specific objectives while adhering to all rules. Often, games involve interactivity, feedback from players, and emotional reactions (Buenaflor, 2024). Conversely, gamification applies gaming concepts but involves the real world outside the game itself. Elements such as graphic and audio design, interaction, rewards, strategies, and competition are utilized as they are suitable for implementation in learning environments (Papadakis, 2021).

This study was conducted to answer the following questions:

- (1) What are the views of vocational school students about the effects of gamification on critical thinking skills?
- (2) What are vocational school students' views about gamification's effects on communication skills?
- (3) What are the views of vocational school students about the effects of gamification on creativity skills?
- (4) What are vocational school students' views about gamification's effects on collaboration and teamwork skills?

2 Literature review

Various other studies that have attempted to demonstrate the impact of gamification on 21st-century skills, particularly the 4C skills (critical thinking, creativity, communication, collaboration), were reviewed to gain a deeper understanding of gamification in the educational environment. This study incorporates several findings relevant to this topic. Not only are the positive impacts discussed, but other phenomena are also revealed to provide a comprehensive understanding. This chapter discusses gamification, 4C skills, and higher education.

2.1 Gamification in higher education

Several current studies are interested in gamification, incorporating game elements for non-gaming activities. A study by Saleem (Saleem et al., 2022) shows that the acceptance of gamification in education continuously increases, and gamification provides significant benefits by enhancing student engagement and creating an attractive learning environment. Gamification elements such as points, badges, leaderboards, and levels enormously motivate students to participate (Alshammari, 2023; Moreno-Ger et al., 2008; Romero & Kalmppourtzis, 2020). However, some practitioners and game designers still cannot determine the best composition of elements to create an optimal gaming environment for educational purposes. Additionally, gamification as a tool for e-learning applications has similar element patterns (leaderboards, badges, points) (Khaldi et al., 2023; Tori et al., 2022). Besides studies on gamification elements, the impact of gamification components has been proven to positively affect students' cognitive skills, motivation, learning behaviour, and learning outcomes (Sailer & Homner, 2020). The popularity of gamification has soared, with several literature reviews (Oliveira et al., 2023) indicating that gamification is currently used in educational systems to enhance concentration, motivation, engagement, and positive learning experiences.

Gamification-based applications incorporating VR elements to enhance student engagement and motivation are widespread in higher education. Huda A (Huda et al., 2021) explain that VR simulations can enhance students' efficiency and competence as a learning medium. Another example, a virtual laboratory incorporating gamification elements (Muskhair et al., 2023; Novaliendry et al., 2021; Ranuharja et al., 2021), demonstrates improvements in students' cognitive abilities and practical skills.

2.2 21st-century skills in higher education

These skills are necessary to support students' future career paths. A systematic literature review by Amelia (Amelia & Santoso, 2021) examined several studies on Project-Based

Learning (PjBL) integrated with STEM, showing improved 21st-century skills. Broadly, PjBL strengthened by STEM enhances 4C skills and students' literacy abilities. 21st-century skills and literacy skills are essential for preparing a golden generation that meets the needs of the industrial world (Indarta et al., n.d.; Samala et al., 2022). Another study (Samala et al., 2023) highlights the potential development of 21st-century skills, demonstrating positive impacts when applied to gamification-based applications. However, external challenges (Nazarian et al., 2024), such as the school environment, lack of parental support, and difficulties in keeping up with the evolving industrial demands, pose substantial challenges in formulating effective learning strategies in schools.

2.3 Gamification and 21st-century skills

Gamification can be used as a learning strategy in online education to develop 21st-century skills such as collaboration, critical reasoning, communication, problem-solving, and digital literacy (Wanglang & Chatwattana, 2023). The development of gamification in Project-Based Learning (PjBL) can be used to assess everyone's 21st-century skills. This study (Wanglang & Chatwattana, 2023) shows a high level of suitability in developing PjBL using a gamification model to enhance students' 21st-century skills. Another study (Mariano & Chiappe, 2021) confirms the impact of learning strategies using gamification as a consideration in designing learning environments to develop 21st-century skills. The study employed an experimental measurement method by examining gain scores before and after implementing a specific treatment. Few studies investigate using both qualitative and quantitative approaches. Therefore, this research aims to examine more deeply by incorporating students' perspectives from questionnaire data and structured interviews.

The study (Samala et al., 2023; Xezonaki, 2022) in Figure 1(a) and 1(b) presents opinions regarding the elements shaping 21st-century skills and gamification. The 21st-century skills, comprising learning skills, literacy skills, and life skills, align closely with elements present in gamification, such as learning, creativity, and competition. Based on this study, gamification and 21st-century skills can potentially enhance student engagement, motivation, and learning outcomes in higher education.

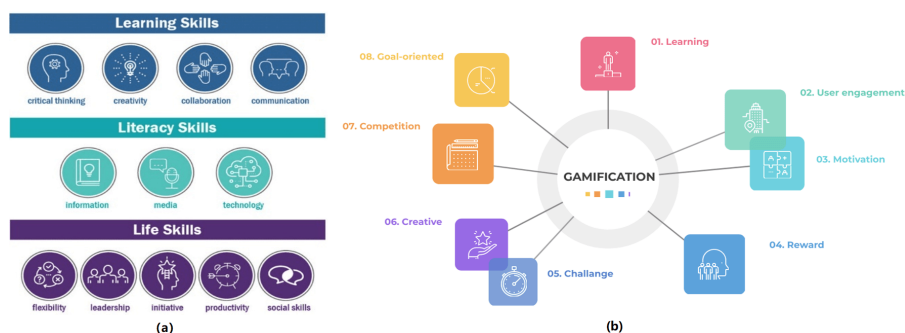


Figure 1 21st Century skills and gamification elements (Samala et al., 2023)

3 Materials and methods

This descriptive study employs a mixed-methods approach, and a diagnostic method (questionnaires) was used to analyze quantitative data and structured interviews for qualitative data. In this study, we employed various scientific knowledge methods. Sharov et al. (2024) believed the steps of analysis and synthesis of several literature studies aided us in identifying the urgency of the impact of gamification on several 21st-century skills. We identified not only the positive effects but also the adverse effects, including the potential risks involved. We suggested developing and administering an online survey using Google Forms to collect data from vocational school students. Several lecturers from various faculties supported the survey distribution. Statistical data processing from the questionnaires and student perspectives from the interviews provide researchers with a better understanding of how to address the issues in this study.

3.1 Population and sample

Data collection was based on a convenient sampling technique. The sample data processing using SPSS software indicated 105 participants from various fields were needed. The participants came from various disciplines within several faculties of the vocational school at Universitas

Negeri Padang in Indonesia. The T-test statistical analysis confirmed the data as usable and reliable.

For the qualitative data phase, six participants were randomly selected. Structured interviews were conducted to gather each participant's opinions. The randomly selected participants met the following criteria: 1) at least two years of gaming experience, 2) currently in their 3rd or 4th semester at university, and 3) experience using smartphones, tablets, PCs, and laptops. This phase aimed to gather feedback on their experiences using gamification to enhance skills such as critical thinking, creativity, communication, and collaboration with other students in learning. Data collection procedures included both questionnaires and structured interviews. The distribution of participants is shown in [Table 1](#).

Table 1 Socio-Demographic respondent

Category	Frequency (N = 105)	Percentage (%)
Gender		
Male	67	63.81
Female	38	36.19
Total	105	100
Age		
17-20 Yo	73	69.52
21-25 Yo	21	20.00
> 25 Yo	11	10.48
Total	105	100
Semester		
1-2	84	80
3-4	13	12.38
5-6	5	4.76
> 6	3	2.85
Total	105	100
Education		
Vocational Degree	73	69.52
Bachelor Degree	32	30.48
Total	105	100
Major		
1. Vocational Technology Education	2	1.9
2. Digital Bussines	30	28.57
3. Information System	2	1.9
4. Informatics Engineering Education	4	3.8
5. Animation	2	1.9
6. Physical Education, Health, and Recreation	4	3.8
7. Library and Archival Information	2	1.9
8. Development Economics	5	4.76
9. Sports Education	2	1.9
10. Economic Education	1	0.95
11. Special Education	2	1.9
12. Informatics	7	6.67
13. Guidance and Counseling	2	1.9
14. Management	17	16.19
15. Elementary School Teacher Education	1	0.95
16. English Language and Literature	3	2.86
17. Educational Administration	2	1.9
18. Legal Studies	5	4.76
19. Public Financial Accounting	1	0.95
20. Logistics Engineering	8	7.62
21. Industrial Electrical Engineering	3	2.86
Total	105	100

[Figure 2](#) explains the distribution of the 105 research participants from various fields of study at Universitas Negeri Padang. The research population included 22 areas of concentration in education and non-education fields. For brevity, we have summarized these concentrations into faculties.

There were 105 participants in total, the majority of whom, 63, were from the field of economics. Other faculties, such as engineering, education, sports, language, and literature, have 5-8 participants each. For a detailed distribution of participant data focusing on their experiences with gamification, devices used, age, and gender.

An analysis was conducted to identify students' devices during their learning activities.

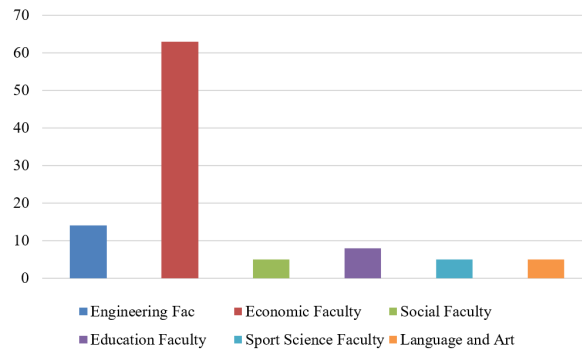


Figure 2 Distribution of participants by faculty

Shonola (Shonola et al., 2016) discovered that students used mobile phones to exchange learning messages and share study materials with classmates. Additionally, some students utilized their devices for internet research and engaging in learning evaluations such as quizzes. However, it was observed that several students used their devices for entertainment purposes rather than effectively utilizing them for academic information retrieval. To address this, a questionnaire item was designed to map out the devices students use at Universitas Negeri Padang, with the data presented in Figure 3.

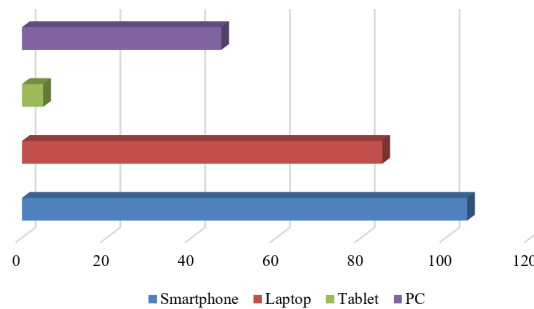


Figure 3 Devices used by learners

3.2 Research instruments

Before distributing the questionnaires, experts assessed the instrument’s validity, both in terms of content and construct. A limited test was conducted with a small class of students outside the research sample to evaluate the instrument’s validity in the initial stages of the study. The questionnaire used a 5-point Likert scale and consisted of 20 items, including tests for Critical Thinking (5 items), Creativity (5 items), Collaboration (5 items), and Communication (5 items). Based on the analysis, the instrument demonstrated a Cronbach’s Alpha value of 0.79, indicating a high level of reliability. The questionnaire results were measured using an adapted version of the instrument developed by Fields & Bischoff (2014). (see in Table 2)

Table 2 Criteria for improvement of student 4C Skills

Mean	Criteria of 4C Skills
0–1.25	Very Low
1.26–2.51	Low
2.52–3.77	High
3.78–5	Very High

4 Results

The questionnaire responses showed that many respondents utilized various devices for gamification learning in the classroom. The majority of students used mobile phones to exchange information with classmates or class groups regarding classroom materials

4.1 Descriptive analysis

Data was processed descriptively through students’ questionnaire responses to the research questions.

4.1.1 Critical thinking

Research Question 1: What are vocational school students' views about the effects of gamification on critical thinking skills?

As shown in Table 3, students' engagement in gaming activities could effectively enhance their critical thinking abilities. The item "Playing games provides intellectual challenges and stimulates students' critical thinking" emerged as significant within the critical thinking questionnaire category, receiving a score (mean = 4.30). Conversely, "Games help you make good and logical decisions" received the lowest ranking in stimulating students' critical thinking, with a score (mean = 4.1). Based on the questionnaire results, gamification elements can enhance students' critical thinking abilities, falling within the 'Very High' criteria.

Table 3 The ability of students to use gamification for critical thinking

	N	Mean	SD	Criteria
"Does playing games enhance your ability to analyze and solve problems?"	105	4.20	1.15	Very High
"Does playing games help you develop your critical thinking skills?"	105	4.28	1.16	Very High
"Do games help you make good and logical decisions?"	105	4.1	1.12	Very High
"Does playing games provide intellectual challenges and stimulate critical thinking?"	105	4.30	1.13	Very High
"The gaming experience facilitates the development of critical analysis skills towards - specific situations or problems?"	105	4.16	1.14	Very High

4.1.2 Creativity

Research Question 2: What are the views of vocational school students about the effects of gamification on creativity skills?

Table 4 illustrates that gamification elements enhance students' creative thinking abilities. The data exhibits a normal distribution with a standard deviation range of 1.15-1.22. For the item "Games provide space for creative and innovative expression for students," a significant score was obtained compared to others (mean=4.38). However, the item "Gaming experiences inspire students to generate new ideas or unique solutions" had the lowest impact among other items, with a score (mean = 4.0). Overall, gamification elements positively impact students' creative thinking abilities, falling within the 'very high' criteria.

Table 4 The ability of students to use gamification for creativity

	N	Mean	SD	Criteria
"Does playing games in the college environment influence your ability to think creatively?"	105	4.03	1.22	Very High
"Does the gaming experience inspire you to create new ideas or unique solutions?"	105	4	1.2	Very High
"Do games provide space for creative expression and innovation?"	105	4.38	1.12	Very High
"Do you feel that playing games provides opportunities to develop your imagination and creativity?"	105	4.35	1.22	Very High
"Does playing games create opportunities to explore creative ideas or innovative solutions?"	105	4.29	1.15	Very High

4.1.3 Collaboration

Research Question 3: What are vocational school students' views about the effects of gamification on collaboration skills?

Table 5 is utilized to measure the impact of gamification on students' ability to collaborate with peers. Survey results indicate that the item "To what extent do students assess the level of cooperation with team members while playing games in the context of higher education?" received a significant score (mean = 4.94), categorized as 'excellent.' Similarly, for the items "Playing games encourages collaboration and problem-solving with fellow students" and "Gaming experiences impact your teamwork skills within the group," both received the same score (mean = 4), falling within the 'good' category, with the lowest value indicating an impact on students' collaborative abilities. The results demonstrate that gamification elements can enhance students' ability to collaborate effectively, categorized as 'Very High.'

4.1.4 Communication

Research Question 4: What are vocational school students' views about the effects of gamification on communication skills?

The testing results presented in Table 6 regarding improving students' communication skills through gamification involvement indicate that these skills did not progress overall. The average

Table 5 The ability of students to use gamification for collaboration

	N	Mean	SD	Criteria
“To what extent do you assess your level of collaboration with teammates while playing games in - the context of higher education?”	105	4.94	1.23	Very High
“Playing games encourages collaboration and problem-solving with fellow students.”	105	4	1.17	Very High
“Does the gaming experience impact your ability to work collaboratively in groups?”	105	4	1.16	Very High
“Do you believe playing games enhances your ability to work in teams?”	105	4.26	1.29	Very High
“Does playing games contribute to your understanding of teamwork and collaboration in a project?”	105	4.12	1.21	Very High

score (mean average = 2.57) falls within the ‘fair’ category. This study demonstrates that gamification could be more effectively utilized to enhance students’ communication abilities.

Table 6 The ability of students to use gamification for communication

	N	Mean	SD	Criteria
“Do you communicate with fellow players while playing games in the college environment?”	105	2.06	1.25	Low
“Has your communication skill improved due to playing games in the academic environment?”	105	2.48	1.27	Low
“Does playing games help you articulate your ideas or opinions more effectively?”	105	2.86	1.26	High
“Does your gaming experience contribute to developing your speaking and listening skills?”	105	2.81	1.22	High
“Does your gaming experience enhance your ability to communicate effectively in an academic environment?”	105	2.64	1.20	High

The data summary in Figure 4 indicates that from students’ perspectives, gamification effectively enhances collaboration skills (average mean = 4.26) among the other 4C skills. However, this score is similar to students’ ratings of creativity and critical thinking skills. Students evaluated that gamification minimally improves communication skills (average mean = 2.57).

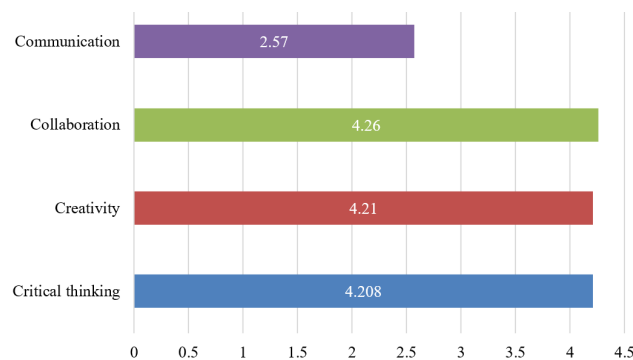


Figure 4 Perspectives of vocational students on 4C skills and gamification

4.2 Interview findings

Furthermore, a Focus Group Discussion (FGD) was conducted with selected students using Zoom meetings. Six participants were chosen based on criteria such as using at least three gamification devices in classroom learning, including smartphones, laptops, PCs, or tablets. These students also had gaming experience from the beginning of their studies until the 4th or 5th semester. The selected students came from the vocational higher education faculty at Universitas Negeri Padang. Each participant was given 10 minutes to answer the questions posed by the researcher. The interview process took 45 minutes, including explaining the purpose, the question-and-answer session, and the interview’s conclusion. The following is a summary and excerpts of the interview results.

“I feel challenged when working on assignments because they resemble games. This is good for stimulating the motivation of students like me who get bored easily. With challenges and rules, I aim to achieve a high score in completing the tasks.”

The first finding indicates that *gamification* can enhance student motivation. When learning tasks are presented as challenges or games, students are more motivated to participate and complete them.

Gamification in education is an exciting way to focus students’ attention on subjects. Some gamification elements, such as design, points, rewards, penalties, etc., create a familiar envi-

ronment for students at home. Most students spend their time playing games at home. With gaming elements at school, I feel it reduces the stress burden on students who spend a long time studying”.

The second interview result shows *that* game elements such as points, levels, and rewards can make learning more engaging. Students will be more active in participating and engaging in the learning process.

“The ability to think critically and provide creative solutions is developed through gamification. From experience, because games can be repeated, students can think more critically to solve problems they have encountered.”

The third finding from participants reveals that players often face problems that require critical thinking and creative solutions in games. With *gamification*, students can actively hone these skills.

“For someone like me who rarely interacts, gamification conditions students to actively cooperate in exchanging information within teams. Gamification fosters cooperation, such as forming parties to explore the gaming world.”

Other findings prove that some games involve cooperation among players. In the context of learning, its impact on educational gamification can *encourage* students to collaborate, discuss, and share knowledge.

“I play various types of games, RPGs, FPSs, tactical games, sims, etc., and each has unique characteristics. Inherent game elements shape these characteristics. The more complex and comprehensive, the more exciting it is to play and enjoy the game’s storyline. In the educational context, this element can be applied to measure the progress of how well they understand.”

The interview findings with the last respondent reveal that game elements allow for more measurable progress measurement. Students can see *how* far they have progressed and improve themselves.

5 Discussion

The current trend in most studies aims to analyze gamification in primary education rather than in higher education. Researchers primarily focus on enhancing students’ cognitive skills, with only a few studies examining interpersonal skills such as critical thinking, creativity, collaboration, communication, negotiation, and adaptability (Yeom et al., 2020). This research focuses on the interpersonal skills related to the 4C skills of students as a reference for future relevant studies. In line with the needs of 21st-century learning, students require suitable learning methods to guide them in achieving their learning outcomes (Ismail et al., 2018). These 4C skills culminate in enhancing students’ higher-order thinking skills (HOTS), providing them with valuable competencies that serve as an investment for a brighter future (Silmi et al., 2022).

Based on the results of questionnaire testing and structured interviews, there is evidence of the influence of gamification on the enhancement of 4C skills and engagement in higher education learning. Several studies indicate a close relationship between the use of gamification in learning and the development of 4C skills (Communication, Collaboration, Critical Thinking, and Creativity) for higher education students. 1) Gamification can enhance student engagement in learning by providing challenging and rewarding experiences. Meanwhile, gamification, learning strategies, and the Project-Based Learning (PjBL) model are implemented to increase student engagement, as demonstrated by Brooks and McMullen (2021). This creates an enjoyable learning environment and motivates students to actively participate in the learning process, skills necessary for effective communication and collaboration. 2) The possibility of replaying gamified learning allows students to refine their skills continually. This allows them to repeatedly practice and improve 4C skills, such as critical and creative thinking, in completing assigned tasks. Both students and teachers experience enhancements in critical and creative thinking through the experience of playing games (Parra-González et al., 2020). Furthermore, 3) gamification can enable personalization in learning, where students can apply knowledge and experiences gained from the real world to gaming situations, further encouraging the development of critical and creative skills as students must adapt their strategies and approaches based on different contexts. 4) Through gamification, students can be evaluated on their progress and reflect on their performance in completing tasks or specific challenges. This activity supports the development of critical thinking skills, as students are required to evaluate and analyze their strengths and weaknesses and find ways to improve their performance in the future. 5) One of the main goals of using gamification is to change students’ behaviour in the real world based on

gaming experiences. Several findings indicate that gamification affects each student's behaviour, depending on their characteristics (Buenaflor, 2024). In the context of 4C skills, this means that students learn to communicate effectively, collaborate in teams, think critically, and generate creative ideas, all of which are highly valued skills in the workplace and everyday life.

6 Conclusion

Gamification, a learning strategy that mimics game elements, has been shown to enhance 4C skills (Communication, Collaboration, Critical Thinking, and Creativity) and student engagement. Challenges and rewards in gamification motivate students to complete tasks and participate actively. Game elements such as design, points, and rewards create an engaging and familiar learning environment. Furthermore, gamification enables students to hone 4C skills through repetition, personalization, and evaluation. The gaming experience in gamification helps students apply 4C skills in the real world, such as effective communication, teamwork, critical thinking, and generating creative ideas. The distribution of gamification learning questionnaires shows that gamification can enhance all three 4C skills (Collaboration, Creativity, Critical Thinking) but not communication skills, which showed less favourable results.

Findings from FGDs with students reinforce the benefits of gamification. Students feel motivated, focused, and trained in critical and creative thinking. Gamification also promotes cooperation and communication among students and enables more measurable measurements of learning progress. In conclusion, gamification is an effective learning strategy to enhance the quality and outcomes of student learning. The widespread implementation of gamification in higher education is highly recommended to prepare students for the real world.

Although this research has demonstrated the impact of gamification on learning, several limitations indicate that further investigation is needed. For instance, in the case of the effect of gamification on vocational school students, by taking respondents from the vocational students of Universitas Negeri Padang Indonesia, totalling 105 people, this study cannot generalize gamification in other higher education institutions. The limited data collection measured the student population. This study suggests gathering data from the perspective of a teacher.

Conflicts of interest

The authors declare that they have no conflict of interest.

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