Online Game-Based Learning to Enhance Student Engagement, Motivation and 21st-Century Skills

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Abstract. In the year 2020 Covid-19 pandemic became a global health concern with significant educational implications. Stay-at-home orders have been issued by governments worldwide, resulting in the closure of institutions and universities. Thereby, educators had to conduct their classes online to ensure educational continuity. However, some of the significant challenges of poorly designed online learning environments were low student involvement in the online classes, which led to the deficit of collaboration, engagement, and motivation. Moreover, our current online learning environments are also limited in addressing students' online learning needs and cultivating critical thinking and problem-solving skills. This study sought to engage students in an online game-based learning environment to improve their problem-solving techniques and increase engagement and collaboration. A mixed-method approach was employed for data collection to gather in-depth and accurate results on students' motivation, engagement and 21st century skills. A 5-point Likert scale survey, and a pre- and post-test were administered online among students to collect quantitative data. Interviews were also conducted to gauge their perception of the online game-based learning environment. Results of the study found that the online game-based learning environment was successful in improving engagement and collaboration in students, and improved their critical thinking and problem-solving skills, providing strong support for using game-based learning in online classrooms and for building successful communities of practice for enhanced student learning experiences.

Keywords: Online learning · Problem solving · game based learning · EduTech · Games in education

1 Introduction

Covid-19 has pushed schools and universities over the technology tipping point in the past few years and caused a comprehensive disturbance to education systems like no other in history. Studies have shown that it has affected approximately 1.7 billion learners in more than 185 countries during the pandemic. The closure of educational institutions has impacted more than 92 per cent of the student population worldwide [1], and educators have been compelled to move their face to face classes to online education using

existing technological tools for collaboration and class deliveries after the World Health Organization designated COVID-19 a pandemic which was a challenging phase [1, 2]. However, technological transformation in higher education empowers learners and gives them the freedom to study whenever and wherever they want. It puts students on the way to personalise learning by giving them control over how they study and solve the real-time problem, making their own decisions and knowledge meaningful and preparing them for their futures. Research has shown that we have improved our learning environment. However, it also shows that there is a need to improve our classroom environments to enhance 21st-century skills and to engage and motivate students in the learning class environment [3]. Therefore, as educators, we must provide students with enough opportunities to indulge and motivate in the class and transform traditional learning into smart learning environments [4, 5].

Education has become essential to improve the quality of living, and its motive is to produce thinkers and problem solvers. However, a considerable amount of literature published during the pandemic shows that there is still a need for advancement in our teaching and learning processes and environments. The challenge now is to develop our current learning environments to enhance problem-solving, critical thinking, and collaboration skills and engage and motivate students in the current learning environment [2, 5].

According to previous research, to develop and enrich problem-solving and critical thinking skills, we need to provide well designed meaningful learning activities to students to see their abilities to solve a problem. Furthermore, recent literature proposed and integrated online game-based learning where students can engage themselves in the class and improve their self-efficacy in sputum suction skill training [6].

However, most studies on online learning and game-based learning for increasing 21st-century skills have concentrated on whether digital games were helpful in improving students' learning outcomes, engagement, and motivation, with a compact study on other components of game-based learning [6].

Therefore in this research, a game was introduced in the online class to enhance students' motivation, engagement and 21st-century skills in a collaborative environment and investigated the effects of the current online game-based learning environment on their learning performance, critical thinking and problem-solving skills.

2 Literature Review

Research has shown that online learning has been having issues with engaging and motivating students and highlighted a deficit of motivation, shortfall of interaction and absence of good collaboration [7] [8]. It also suggested integrating educational games into an online learning environment to increase student engagement and motivation. Research by [9] and [10] found that students found it challenging to study online, citing the following issues:

1. When assigned an online activity that was not well explained, students become distracted.
2. When requested to search an online database for information, students felt isolated and demoralised since the available resources were beyond their comprehension.

3. The lecturer's content was difficult to understand by the pupils.
4. Students have difficulty engaging with their classmates and instructors in class.
5. It might be difficult for pupils to avoid boredom when studying online.

Therefore, to better engage students in online learning, there is still a need to find more creative and effective ways to redesign our online learning environments to engage, motivate, and improve problem-solving and critical thinking skills [11] [12].

2.1 Communities of Practice (CoP) in Online Learning

There is strong evidence in research that community of practice (CoP) can be adapted in the redesign of online learning environments. Given the advances in online interactive learning tools, other researchers propose jointly building knowledge within tasks focused [15].

A community of practice (CoP) comprises a group of people who share the same concern and passion for what they do and discover how to do it better via regular interaction with their peers. They also help other community members to grow and improve together. This study adapted [17]'s idea to design an online game-based learning environment. It involves three main elements that form a community in an online learning class where students interact and collaborate to complete their projects. The main three elements are (1) Domain, (2) Community and share their knowledge in the shared domain, (3) Practice: Students used multiple tools, strategies their ideas according to the need of the task and collaborated to achieve their common goals [17].

2.2 Game-Based Learning

In recent years, game-based learning has received an increasing amount of scholarly interest. The benefits of game-based learning have been thoroughly tested in higher education, and they have been shown to be generally promising in terms of motivating learners, increasing their engagement in class, and improving learning performance and perceptions. Furthermore, educational games may lead students to enjoy learning, feel comfortable with multiple challenges during the learning process, and overcome these challenges with concentration, confidence, and patience, all of which are important for higher education in the development of lifelong learners [13]. There is evidence that game-based learning (GBL) plays an important role in increasing engagement in a learning environment. [14]. These principles are categorised into 3 main domains, namely (1) Empowered learners: To engage students we need to allow them to become active learners, (2) Problem-solving: To foster their thinking and problem solving and critical thinking we need to provide well designed problems and (3) Understanding: Allow students to think and decide which path they are going to take to solve the problem. Table 1 shows the [14] game based learning principles.

When learners collaborate in a game-based learning environment, they share ideas and information and support one another in achieving their mutual goals. The existing literature on game-based learning shows that collaboration in the game leads to higher learner engagement and helps enhance our critical thinking and problem-solving skills [13].

Table 1. Game-Based Learning [14]

SR: No	*Principle*	
1	Empower Learners	1: Co-design 2: Customize 3: Identity 4: Manipulation and Distributed Knowledge
2	Problem Solving	5: Well-ordered Problems 6: Pleasantly Frustrating 7: Cycles of Expertise 8: Information 'On Demand' and 'Just in Time' 9: Fish Tanks 10: Sandboxes 11: Skills as Strategies
3	Understanding	12: System Thinking 13: Meaning as Action Image

Although various research on game-based learning for enhancing 21st-century skills has been undertaken, most have focused on whether games lead to effective learning, provide good engagement, or boost students' motivation. There has been little investigation into game-based learning's collaboration, competition, and storytelling modes. As a result, it is unclear how solitary, competitive, and collaborative gaming modes affect students' engagement, motivation and 21st-century skills.

Therefore, this study aimed to investigate the effects of integrating game-based learning in an online learning environment, within a community of practice (CoP), on student learning process and experiences. The study sought to answer the following research question, *"What is the impact of a game-based learning environment on student learning experiences?"*.

3   Methodology

The class design for this study is below.

3.1   Class Design

In this study, a conventional online course in the design faculty was redesigned to integrate [14] game-based learning elements and embedded within [15] community of practice learning environment. The course taught was *"Internet Applications"* and was conducted online. Table 2 presents the mapping of the class to Wenger'scommunity of practice (CoP).

According to game-based learning theory, students are most likely to be deeply engaged and immersed in an optimal experience when they are actively involved in specific activities in class. Therefore, a game activity was introduced in the class for the

Table 2. Community of practices class implementation

Community of Practices (CoP)	Game-Based Learning
Domain	A group project was assigned to the students.
Community	(1) Students will form groups (2) pick a topic for project (3) share their knowledge to achieve one goal.
Practice	(1) Used Design and Development Tools (2) Students were provided with multiple tasks for practice for each class.

Table 3. Game-based learning implementation.

Game-Based Learning	Class Implementation
Learner Empowerment	(1) Students form groups (2) Students were provided with different activities and assignments. (3) Students were allowed to pick their roles to complete the task.
Problem-Solving	(1) Lecturer gave small problems as to solve. (2) A flexible role playing environment was provided for interaction among the groups/teams.
Understanding	(1) A group/team project was assigned. (2) Each activity and problem were designed to engage, motivate and foster student's critical thinking, problem-solving and decision-making skills.

Fig. 1. Inside Game Instructor where students were greeted and prepared to enter the game

students to interact and collaborate to complete their class activity. Table 2 illustrates game-based learning implementation in the online class (Table 3).

Figures 1, 2 and 3 show the game activity integrated into an online class to engage and motivate the students.

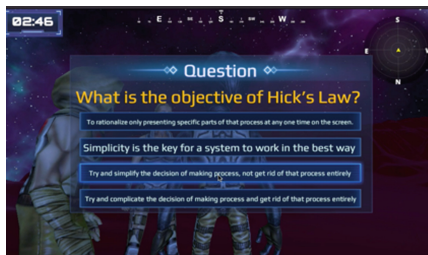**Fig. 2.** Inside Game collaboration where students choose an avatar and enter the game as group

Fig. 3. Student teams solving the problem inside the game

3.2 Research Design

The study utilized a mixed method research design, and was conducted on a convenient sampling of 48 students from the course. The participants were given a consent form to fill and were told that the study was voluntary. Only those who consented to participate were given the link to the game. For the participating students, the game began with a 10–15 min briefing session. When all participants were clear about the objective of the data collection, they were given a pre-test to gauge their prior knowledge about the subject/topic. After taking the pre-test, the students were given the link to the game to evaluate their performance as a team and enhance their problem solving, critical thinking, and collaborative skills. After completing the game, students were then given a post-test and a survey with open-ended questions to complete.

4 Results and Analysis

4.1 Students Pre-test and Post-test Performance

This test aimed to see students' current understanding level of the subject. To begin this data collection, the participants received an explanation of the pre-test / post-test prior to the students being taught using the online game-based learning environment. They were then provided with the pre-test (first instrument of this study) individually and were asked to answer according to their understanding. They were given 30 min to answer 26 multiple choice questions where 6 questions were about the student's consent, age, gender, nationality, race, and level of study, and 20 questions were about the overall

Table 4. Paired Sample T-test

		m = Mean	n = Number of Participants	Std. Deviation	Std. Error Mean
Pair1	Post-Test Results	13.38	81	2.517	.280
	Pre-Test Results	9.40	81	2.853	.317

Table 5. Paired Sample T-test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Sig (2-tailed)
					Lower	Upper			
Pair1	Post-Test Pre-Test Results	4.06744	3.58616	.39846	3.27447	4.86040	10.208	80	< .001

subject. The data were recorded in an online google classroom through a google form, and data analyses were carried out using SPSS, version 27. A paired sample t-tests were carried out to assess whether there are any significant changes in the student's performance. The results obtained from the collected data are shown in the table.

Table 4 and 5 presents the summary statistics for the paired sample pre and post-test results. The post-test mean is m = 13.38 and m = 9.40, and Table 5 shows the significant differences $p < .001$, between the two sets of tests. The T-Test findings suggest that students' performance improves after participating in collaborative and competitive game-based activities. It also demonstrates that the student's experience with an online game-based learning environment prior to their post-test was beneficial and effective in boosting their grasp of the subject.

4.2 Students' Responses to the Survey Questionnaire

After the pre and post-test, a survey questionnaire was then given to the individual participant after taking their consent. This survey aimed to see their perception of the online game-based learning environment and how it helped improve their problem solving, critical thinking, and group collaboration skills and how much this class environment was engaging and motivating. The survey was designed for this study with the Likert scale questionnaire (5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree and 1 = Strongly Disagree) were designed to measure four constructs which are:(1) Problem-solving, (2) Critical thinking, (3) Engagement, and (4) Motivation.

As shown in Table 6, the overall results indicate that participants enjoyed and liked online game-based learning classes. It also showed that students were more likely to work in groups (Item = 1, m = 3.71, p = 54.2) to learn new things. 77.1% of students agreed that working in a group helped them explore and implement the new ideas (Item =

Table 6. Survey Results of the Learning Environment

A Survey Questions			
Survey Item (online game-based learning) N = 48	*Mean*	*Std Deviation*	%
1. I prefer to work in a group so I can learn new things	3.71	0.944	54.2
2. Working in a group gives us an opportunity to explore and implement new ideas	4.10	0.831	77.1
3. I can now examine how others gathered and interpreted ideas/information and assess the accuracy of the conclusions.	3.92	0.098	73
4. We managed to assign tasks effectively and follow a plan.	3.77	0.944	68.7
5. I believe the knowledge acquired during the group project will benefit me in future.	4.02	0.863	77.1
6. The group project helped me to understand the subject better.	3.75	0.863	64.6
7. I was highly motivated to work on a group project.	3.88	0.890	68.8
8. I am happy that I was able to share my creative ideas and managed to implement them in our group project.	3.94	0.836	66.7
9. I enjoyed my interaction with my teammates.	3.94	0.783	66.7
10. I enjoyed coming to our group meetings.	3.92	0.821	66.7
11. This game keeps me engaged with the content.	3.91	0.785	66.7
12. I feel highly satisfied with the game design and content?	3.85	0.945	66.7
13. I was having fun and was deeply involved in the task?	3.77	1.016	71.7
14. I feel this game help me to understand the concept better	3.71	1.071	62.5
15. In my opinion, games foster critical thinking.	3.77	0.72	60.5
Cronbach's Alpha = .975			

2, m = 4.10). Also, 73% of students acknowledge that they can now effectively examine and analyse how others gather and interpret information and assess the accuracy of the conclusions (Item = 3, m = 3.92). 68.7% managed to follow the plan and assign tasks to each other (Item = 4, m = 3.77), and 77.1% believe that the knowledge they acquired during their group project will benefit them in future (Item = 5, m = 4.02).

Furthermore, 64.6% of students reported that group work helped students to understand the subject better (Item = 6, m = 3.75). More than 68% of students reported being motivated while doing their group project (Item = 7, m = 3.88, 68.8). Results also showed that 66.7% were happy to share their knowledge with their team members, which helped them to come up with creative ideas (Item = 8, m = 3.94, 66.7), 66.7% of them enjoyed their team interaction (Item = 9, m = 3.94, 66.7) and most of them were enjoyed their meeting discussion (Item = 10, m = 3.92). Moreover, 66.7% of the students stated that they were engaged with the content while playing the game (Item = 11, m = 3.91, p = 66.7) and felt highly satisfied with the game design and content

Table 7. Student comments

Comments:
1. my motivation in this trimester is to get 4.0 in my GPA and to unleash my full potential in this course.
2. "Solving problems together will certainly make it easier, as well as more fun."
3. "It's good because different skill assets can be used while doing the group project, and we can help each other to improve."
4. "It is fun to work together and we can know each other more than we know"
5. "I feel that we can gain a lot of knowledge together"
6. I feel great about it and felt wow when they share their knowledge to me as well.
7. Solving problems as a group allows more solutions being conjured up and more opinions from each member. Therefore, the possibility to solve a problem would vary and whichever one is chosen, i would respect it.
8. I feel that this is the best and fastest way to achieve success in building a project

(Item $= 12$, m $= 3.85$, 66.7). 71.7% of students reported they had fun and were deeply involved in the task (Item $= 13$, m $= 3.77$, 71.7). Furthermore, 62.5% of students feel that this game helped them understand the concept better (Item $= 14$, m $= 3.71$ p $= 62.5$), and 60% said that games help them foster their critical thinking (Item $= 15$, m $= 3.77$, 60%). Reliability analysis was performed and yielded a Cronbach Alpha of .975.

Table The research has been focused on enhancing problem-solving skills with online game-based learning. The data gathered through pre-test, post-test, student questionnaire, and class activity all point to the study's success. Overall, students were actively engaged in group discussions and came up with different solutions to solve a problem and more importantly, they had fun. Specifically, this study found that:

In order to make survey results more stronger, students were requested to give their comments in regards to engagement, motivation, collaboration. Some of the comments are mentioned in the Table 7. Some of the students stated *"my motivation in this trimester is to get 4.0 in my GPA and to unleash my full potential in this course."*. Furthermore they have mentioned that *"Solving problems together will certainly make it easier, as well as more fun"*. Students also mentioned *"It is fun to work together and we can know each other more than we know"*. They also feel *"that this is the best and fastest way to achieve success in building a project"*.

Results of the overall comments were very positive and they were excited to use games in the education in future.

5   Discussion

The research has been focused on enhancing problem-solving skills with online game-based learning. The data gathered through pre-test, post-test, student questionnaire, and class activity all point to the study's success. Overall, students were actively engaged in group discussions and came up with different solutions to solve a problem and more importantly, they had fun. Specifically, this study found that:

[1] The game helped students to engage with the content and allowed them to enter inside the game as a team to complete their mutual challenge. The study results showed that it helped them solve the given problem more effectively and allowed deep thinking and understanding of the topic. This element sparked their motivation, leading them to be deeply involved in the problem and effectively strategies the solution.

[2] Data results showed that game effectively engaged students with the game content and involved them deeply in the given problem, which helped students improve their problem-solving skills.

[3] Survey results and comments showed that the motivation through the available educational online networks and integration of the games in the learning process allows students to be effectively motivated and collaborate to solve a common problem.

[4] The results also showed that in the online collaborative game environment, students initiate discussion to solve a problem which enhances their understanding of the topic/subject. In conclusion, collaboration helped students share their knowledge and ideas to strategies and plan for the future.

[5] Results also showed that the providing a project and let students to communicate for the group works showed significant improvement in student's knowledge and improvement in their problem solving and critical thinking skills.

6   Conclusion

In this study, a game was created and introduced in the class to improve learning and see the impact of collaboration, motivation and engagement to foster 21st-century skills in online classrooms. The overall study results showed that collaborative and challenging activities help students to improve their problem-solving and critical thinking skills and engage them deeply in the scenario. These findings show strong support for using game-based learning in online classrooms and for building successful communities of practice for enhanced student learning experiences.

References

1. Demuyakor, J. (2020). Coronavirus (COVID-19) and Online Learning in Higher Institutions of Education: A Survey of the Perceptions of Ghanaian International Students in China. Online Journal of Communication and Media Technologies, 10(3), e202018. https://doi.org/10.29333/ojcmt/8286.

2. Ali, W. (2020). Online and Remote Learning in Higher Education Institutes: A Necessity in light of COVID-19 Pandemic. Higher Education Studies, 10(3), 16.

3. Limna, P., Siripipatthanakul, S., Phayaphrom, B., & Siripipattanakul, S. (2022). The Relationship Between Twenty-First-Century Learning Model (4Cs), Student Satisfaction and Student Performance-Effectiveness. International Journal of Behavioral Analytics, 2(1), 1-18.

4. Wang, X., Hall, A. H., & Wang, Q. (2019). Investigating the implementation of accredited massive online open courses (MOOCs) in higher education: The boon and the bane. Australasian Journal of Educational Technology, 35(3), 17. https://doi.org/10.14742/ajet.3896.

5. Hellerstein, D., Waldman, T., Juel Solomon, H., & Arnon, M. (2020). When Students Can Choose: Online Self-Study or In-College Learning of English for Academic Purposes. World Journal of English Language, 10(2), 25.

6. Danka, I. (2020). Motivation by gamification: Adapting motivational tools of massively multiplayer online role-playing games (MMORPGs) for peer-to-peer assessment in connectivist massive open online courses (cMOOCs). International Review of Education, 66(1), 75-92.

7. Gilyazova, O. S., & Zamoshchanskii, I. I. (2020). On motivational tools of gamification in higher education: theoretical aspect. Perspectives of Science and Education, 45(3), 39–51. https://doi.org/10.32744/pse.2020.3.3

8. Martin, F., & Bolliger, D. U. (2018). Engagement Matters: Student Perceptions on the Importance of Engagement Strategies in the Online Learning Environment. Online Learning, 22(1). https://doi.org/10.24059/olj.v22i1.1092

9. Puspita, E. (2022). Challenges and Strategies in Online Learning Process During Covid-19 Pandemic: The Students' Voice. Jurnal Penelitian, Pendidikan, dan Pembelajaran, 17(1).

10. Reese, S. A. (2015). Online learning environments in higher education: Connectivism vs. dissociation. Education and information technologies, 20(3), 579-588.

11. Paudel, P. (2020). Online Education: Benefits, Challenges and Strategies During and After COVID-19 in Higher Education. International Journal on Studies in Education, 3(2), 70–85. https://doi.org/10.46328/ijonse.32

12. Erdoğdu, F. (2022). Online Knowledge Construction for Teachers on Social Media: A Community Perspective for Practice. Asian Journal of Distance Education, 17(1). http://asianjde.com/ojs/index.php/AsianJDE/article/view/585/365

13. Mao, W., Cui, Y., Chiu, M. M., & Lei, H. (2021). Effects of Game-Based Learning on Students' Critical Thinking: A Meta-Analysis. Journal of Educational Computing Research, 59(8), 1682–1708.

14. Gee, J. P. (2005). Learning by Design: Good Video Games as Learning Machines. E-Learning and Digital Media, 2(1), 5–16. https://doi.org/10.2304/elea.2005.2.1.5.

15. Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., Simeoni, Z., Tran, M., & Yukhymenko, M. (2012). Our princess is in another castle: A review of trends in serious gaming for education. Review of Educational Research, 82(1), 61–89. https://doi.org/10.3102/0034654312436980