Early Study of Gamification for Enhancing Post-Pandemic Learning through the Utilization of Collaborative Learning Algorithm

Aulia Zikri Rahman*, Saskia Kanisaa Puspanikan, Wiku Larutama

Logistics Engineering, Universitas Pendidikan Indonesia, Indonesia
*Email: azikrirahman@upi.edu, saskia.kanisaa@upi.edu, wiku.larutama@upi.edu

ABSTRACT
In the post-pandemic situation, it can be quite challenging to enhance students' learning experience. One promising approach is gamification, which involves applying game elements and mechanisms in the context of education. Gamification utilizes game elements such as points, levels, challenges, and rewards, which can create a more engaging and enjoyable learning experience for users. This study aims to explore the potential combination of gamification and collaborative learning algorithms in the context of post-pandemic education. This process is carried out using the systematic literature review method, which involves exploring reference sources. From the aforementioned studies indicate a strong connection between gamification elements and collaborative filtering algorithms in educational contexts. By integrating collaborative filtering techniques, educational applications can enhance the learning experience by personalizing content, providing feedback, and promoting engagement and motivation among learners. These findings contribute to the growing body of knowledge regarding the effective integration of gamification and collaborative filtering algorithms in educational settings.

Keywords: *Blended Learning, Mobile Learning, Post-Pandemic Learning.*

1. INTRODUCTION

In the post-pandemic situation, it is important for us to explore how technology can be used to enhance students' learning experiences and overcome the challenges faced in remote learning. One promising approach is gamification, which involves applying game elements and mechanisms in the context of education. In this journal, researchers explore the potential of gamification in improving post-pandemic learning through the utilization of collaborative learning algorithms.

In the field of education, there are three different learning approaches with distinct characteristics. Some commonly used approaches are pedagogy, andragogy, and heutagogy, which are currently widely employed. Heutagogy shares similarities with andragogy, where learners act as the center, and the context of discussions is not always related to the subject matter but emphasizes learners' initiatives and demands their creativity in discovering things they enjoy while still being measurable. In other words, the heutagogy method aims to create a learning environment that provides freedom in determining goals, learning path processes, and setting the output of previously agreed-upon goals[1]. This method is considered suitable when combined with gamification, which includes elements of spontaneity and active engagement of each learner.

Gamification has been proven effective in enhancing students' motivation and engagement in learning. By utilizing game elements such as points, levels, challenges, and rewards, gamification can create a more engaging and enjoyable learning experience. Additionally, collaborative learning algorithms enable interaction and collaboration among students, enriching the learning experience by facilitating knowledge exchange, discussions, and cooperation.

Through this research, the researchers aim to explore the potential combination of gamification and collaborative learning algorithms in the context of post-pandemic education. The researchers will analyze the impact of gamification on learning motivation, student engagement, and their learning outcomes. Additionally, the researchers will investigate the effectiveness of

A. Kusumastuti et al. (eds.), *5th Vocational Education International Conference (VEIC 2023)*,
Advances in Social Science, Education and Humanities Research 813,
https://doi.org/10.2991/978-2-38476-198-2_54

collaborative learning algorithms in enhancing interaction and collaboration among students.

By gaining a better understanding of the potential of gamification and collaborative learning algorithms, this can be further developed into an alternative learning method to accommodate post-pandemic education with an innovative and effective approach. This research can provide valuable insights for educators, educational software developers, and other stakeholders in designing a learning environment that combines collective intelligence and excitement in the learning process.

In this journal, the researchers will discuss the theoretical framework underlying gamification and collaborative learning algorithms, explore existing related research, outline the research methodology used, and present findings with the hope that this research can support efforts to create a better learning experience in the post-pandemic era.

2. THEORETICAL BASIS

The theoretical basis chapter on this research serves as the foundation, providing a framework to understand and analyze the subject matter. It outlines the key theories, concepts, and existing literature that inform the study, allowing the reader to grasp the theoretical underpinnings of the research. This paper's theoretical basis relies on referencing literature from several sources like journal, book chapters, specifically focusing on learning media, gamification, and artificial intelligence research.

2.1. Recommender System

Recommender systems are part of the field of artificial intelligence (AI). Recommender systems utilize AI algorithms and techniques to analyze user data and provide relevant recommendations based on user preferences and behavior. Recommender systems can be found in various platforms and services such as e-commerce websites, music or video streaming platforms, news applications, and many more. They work by collecting user preference data, such as purchase history, ratings, searches, or other interactions, and use algorithms to analyze this data and generate personalized recommendations based on individual interests.

Artificial intelligence techniques used in recommender systems include collaborative filtering, content-based filtering, knowledge-based, and hybrid approaches[2]. Recommender systems continue to evolve using technologies such as machine learning and deep learning to improve accuracy and personalization. Therefore, recommender systems can be considered as one of the applications of artificial intelligence that aim to assist users in discovering relevant content or products and tailor their experiences on an individual level.

2.2. Collaborative Filtering

Collaborative filtering is a powerful recommendation technique that predicts user preferences by analyzing similarities with other users or items [2, 3]. It operates on the principle that users who have similar tastes in the past are likely to have similar preferences in the future. By examining user-item interactions, collaborative filtering generates personalized recommendations by utilizing the collective knowledge of the user community. It compares user preferences or item similarities to produce accurate and relevant results, making it an effective tool for recommendation systems in various domains.

Through collaborative filtering, recommendation systems can provide users with tailored recommendations based on the opinions and behaviors of similar users. By analyzing user-item interactions and identifying patterns of similarity, collaborative filtering predicts the preferences of the target user for items they have not yet encountered[3]. This technique addresses the cold-start problem and continuously learns and adapts as new user-item interactions are recorded. The outcome is a personalized and dynamic recommendation experience that enhances user satisfaction and engagement. Collaborative filtering's capacity to harness the collective wisdom of the user community makes it a valuable approach for generating accurate and relevant recommendations in recommendation systems.

2.3. Gamification

The relationship between gamification and collaborative filtering lies in their shared goal of enhancing user experiences [4, 5]. By combining gamification techniques with collaborative filtering, recommendation systems can create more engaging and personalized experiences for users. Gamification elements can be incorporated into the recommendation process, such as awarding points or badges for interacting with recommended items or achieving certain goals. This approach not only makes the recommendation process more interactive but also increases user motivation and participation. Furthermore, this integration can create a more tailored and engaging gamified experience, as the recommendations are based on the collective wisdom and preferences of similar users.

3. METHODS

Collaborative filtering is a technique commonly employed in gamification to enhance user experiences and engagement. By implementing collaborative filtering algorithms, game designers can recommend personalized

game elements, challenges, or rewards based on the preferences and behaviors of similar players. This approach enables the creation of dynamic and tailored gaming experiences that align with individual player preferences and increase overall engagement. Collaborative filtering in gamification empowers game developers to deliver targeted and relevant content, fostering a sense of personalization and enhancing the overall enjoyment and satisfaction of players.

The process of introducing literacy begins with exploring reference sources available in databases such as IEEE and Scopus. This study using systematic literature review method, focuses on research journals related to technology, logistics, and supply chain. To identify relevant studies, specific keywords like "Artificial Intelligence," "Learning Media," and "Gamification" are employed. The selection of references involves a filtration process that includes eliminating irrelevant titles, selecting abstracts, and assessing the methodologies used. The primary emphasis of the analysis is placed on examining the methodology and discussion sections of the selected studies. Essential points from each study are recorded to extract information about the objectives and methodologies employed. Through the implementation of this filtering process, reference papers relevant to the research topic are acquired. It can be seen in Figure number 1.

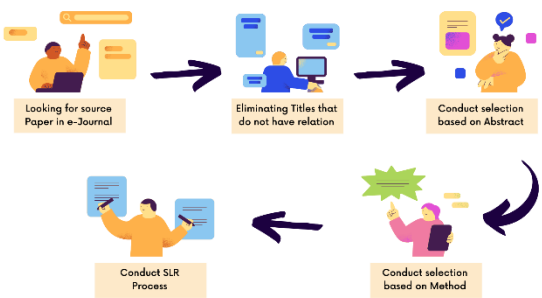

Figure 1. Schematic Diagram of Literature Review

4. RESULTS

The findings from the studies that have already gathered demonstrate a connection between gamification elements and collaborative filtering algorithms in the context of educational applications. The development of mobile devices applications has paved the way for innovative approaches in education. Drawing inspiration from behavioral models and educational theories, Enea mele *et al*[4] utilized the Fogg's Behavioral Model (FBM), Bloom's taxonomy, and the 'flow' model to generate gamified educational content. By incorporating gamification elements and add-ons, they enriched the learning experience, offering features such as dashboards, progress bars, and badges to track and motivate student progress. The use of levels, quizzes, leaderboards, and the Stash block further enhanced the learning environment, fostering engagement and personalization. Through these gamification features, Moodle empowered student-centered course development and facilitated the achievement of higher-level learning outcomes. These elements served as collaborative filtering mechanisms by personalizing the learning experience based on individual student performance and engagement. The inclusion of these gamification features resulted in an enriched learning experience, providing students with a sense of progress and motivation.

Heryadi *et al* [5] conducted a study with the objective of designing a prototype of a Mandarin m-learning application on Android and comparing the effects of gamified and non-gamified methods on the learning experience. The research involved dividing the sample into two groups: one using the gamified method and the other using the non-gamified method. The data collection method employed was structured self-administered questionnaires. The results indicated that gamification showed significant improvements in concentration, learner skills, feedback, and immersion. These findings suggest that the incorporation of gamification techniques, potentially employing collaborative filtering algorithms, can enhance the learning process by tailoring it to individual student preferences and needs.

Lopez *et al*[6] focused on creating a simulation of theoretical examinations, promoting collaboration and motivation among touristic guides seeking accreditation. The collaborative tool allowed users to contribute their own questions, which greatly enhanced the app's usefulness and prepared learners for the examination. This can be seen in Figure number 2.

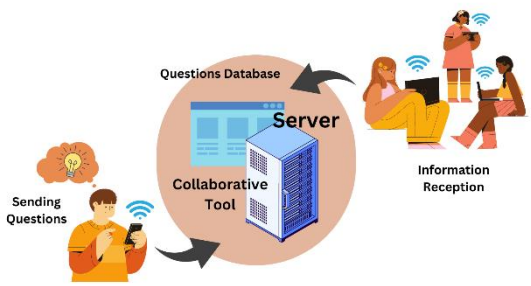

Figure 2. Application Flow

Building upon the concept of Gamification, Tri Sagirani *et al* [7] developed MoLearn, a learning application that aligned learning strategies with learners' activities, device advancements, and social conditions. The application focused on standardizing learning materials, ensuring they met competency standards, basic competencies, and indicators. MoLearn also incorporated

various features to support classroom learning. Future development will integrate the Gamification concept, transforming the user experience into a game-like process through game elements, mechanisms, and thinking. The application's designs for character, interactivity, and feedback elements take into account student goals, reward mechanisms, and progress tracking, while incorporating gamification features like rules, rewards, leaderboards, points, medals/badges, leveling, and sharing. These features can be considered as collaborative filtering mechanisms, as they utilize algorithms to recommend personalized learning activities and resources based on the learner's profile and preferences. This approach enhances the engagement and motivation of learners, facilitating a more effective learning experience.

To ensure accessibility and compatibility, Martin *et al*[8] delivered an application that can be accessed on different devices. By utilizing web technology, the application became compatible with a wide range of smartphones. The interface was designed to be interactive and adaptable, catering to different screen sizes. Users could engage in various learning actions, track their progress, and manage personal information. Teachers had the ability to set tags for filtering, while contributors and reviewers played a crucial role in creating and reviewing learning materials. The system intelligently selected relevant cards based on subjects, categories, and subcategories, allowing learners to focus on their specific areas of interest. Furthermore, learners could monitor their achievements and compare their performance through leaderboards. This comprehensive learning platform effectively bridged the gap between individual needs and the collaborative efforts of various stakeholders involved in creating and organizing learning content. The selection process utilized collaborative filtering algorithms, which analyzed user preferences and behavior to recommend personalized and relevant learning resources. This approach demonstrated the potential of collaborative filtering in supporting personalized learning pathways and improving the overall learning outcomes.

Sanjaya *et al* [9] carried out research with the aim of of exploring the development of a Gamification-based Application Model to enhance student motivation. The research employed methods such as interviews, observations, and document analysis. The findings revealed that students often felt bored and faced difficulties in understanding course materials. To address these challenges, the designed gamification application needed to accommodate six key features: interactive quizzes, interactive case studies, achievements badges, student rankings, scoreboards, video-based forums, and achievement reports.

Sarkar *et al* [10] performed a study with the goal of designing a game that could be used as a programming learning method by combining the advantages of gamification and edutainment. The methodology involved the development of a competitive RPG game with features such as leaderboards and social sharing. Unity3D was utilized to create a cross-platform game. The researchers collected data through questionnaires and tested the game on five different devices, which demonstrated its compatibility with devices ranging from low to high performance. The results showed that out of the 17 students who tried the game, they liked it and found it easy to play and addictive. Additionally, 60% of the students were able to successfully answer programming-related questions, indicating the effectiveness of the game as a learning tool.

Yue *et al* [11] conducted a study with the objective of examining the effects of gamification in Malaysian History learning through the use of a Mobile Game Application called History Learning Mobile Game (HLMG). The methodology involved evaluating the Player Progress Scene, conducting a Focus Group Study, and administering a questionnaire consisting of 9 items to assess the effectiveness of HLMG. The results showed that overall, the functions within HLMG performed well. However, the game was found to have shortcomings in terms of lacking animations and the quality of graphics, affecting the user experience. On the positive side, aspects such as Story, Gameplay Complexity, Average Play Session, Engagement, and Historical Content Delivered received positive feedback from the respondents.

Troyer *et al* [12] aimed to design an application that could reduce burnout levels and motivate students to explore their environment. The methodology involved designing an application with the concept of unconscious and micro learning, implementing a playful environment through gamification, and creating a more personalized application. The result was the development of an application called TICKLE, a mobile location-based application consisting of a Cards module and Diary. The application allows students to explore their surroundings using a game-like approach, complete with missions and achievements. TICKLE provides an engaging and interactive experience for students, encouraging them to actively participate in their environment.

Mridula *et al* [13] created an e-health app using gamification to address the problem of excessive smartphone and tablet use, especially among Gen Z. The app has missions for users to complete, and they receive rewards for finishing them. These missions promote healthy smartphone usage to prevent mental and physical issues. The app, available on Android, went through stages like design and data visualization. You can find the

app at github.com/Digital-Health-Helper/AppTimer, showing usage diagrams and time limits for each app. Although it's still in beta, tests have shown that using gamification with missions and rewards effectively engages users, especially Gen Z. This initiative by parents aims to reduce smartphone usage.

MOOCs are free online courses offered to thousands of students through platforms like Coursera and Open edX. They are widely used by universities to support blended learning. SPOCs are similar to MOOCs but cater to smaller groups. To enhance collaboration and adapt to mobile learning trends, Luis *et al* [14] suggests MyMOOCSpace, a game-based mobile app for online courses. It focuses on Computer Supported Collaborative Learning (CSCL), which encourages teamwork and motivation. The app was tested in SPOC training, where student groups used it to progress through modules. Questionnaires were given before and after to evaluate collaboration. Results showed that MyMOOCSpace promotes collaboration and engagement among students, complementing existing SPOC course features.

Learning and understanding STEM (science, technology, engineering, and mathematics) can be challenging for educators. Pirker *et al* [15] presents a theoretical model that explains how to use gaming elements in courses and create a gamification framework. The model is based on existing gamification techniques to make educational science simulations more engaging. Online laboratories face a steep learning curve, especially in the beginning when users need to learn how to interact with virtual tools. Gamification for education involves two main things: interaction and feedback. Interaction includes small tasks and assignments that should be balanced (not too hard, not too easy) and interactive (with constant user involvement). Users should receive continuous feedback like points, rewards, or rankings to motivate them. This feedback should cater to different student motivators like collaboration, competition, or recognition.

Some educators see games as a valuable and even necessary learning environment suitable for learners of all ages. However, there are challenges in integrating games into formal institutional learning settings where intellectual content takes precedence. In the research by blunt *et al* [16], summarizes research on the use of games in learning, utilizing the Attention-Relevance-Confidence-Satisfaction (ARCS) model and providing real-world examples. In a study, the difference in academic achievement between students using games in learning and those who did not was examined. Data analysis showed that classes using games significantly outperformed those without games. There were no significant differences between male and female scores, but both genders scored higher with games than without. There were no significant differences between ethnic groups, but all ethnic groups scored higher with games. Lastly, students below the age of 40 scored significantly higher with games, while students aged 41 and above showed no significant differences.

Lastly, paiva *et al* [17] explores how gamification can be used in the context of undergraduate education to motivate teachers and improve their performance, consequently enhancing the outcomes achieved. The study was conducted at the School of Technology and Management (Escola Superior de Tecnologia e Gestão - ESTG), one of the six schools within the Instituto Politécnico de Viana do Castelo. The teacher evaluation system is the same across all six schools and is determined by the Presidency of the polytechnic. This research paper demonstrates the levels that will be created, the rules and rewards, and also presents a UX prototype of an Android application that will be used to test the prototype. The study concludes that implementing gamification will enhance teacher motivation.

The studies discussed in this text highlight the connection between gamification elements and collaborative filtering algorithms in educational applications. The incorporation of gamification techniques, such as dashboards, progress bars, badges, quizzes, leaderboards, and personalized recommendations, has been shown to enrich the learning experience, foster engagement, and enhance student motivation. Gamification-based applications have demonstrated positive effects on concentration, learner skills, feedback, immersion, and student performance.

The gamification method still has room for improvement such as presenting content that can be personalized for each individual. One alternative solution that can be applied is to combine collaborative filtering recommendation algorithms which is the method proposed in this study. In previous research discussing gamification in learning, collaborative mechanisms have been implemented and this has the potential to be combined with the recommender collaborative filtering algorithm in improving the overall learning outcomes, reducing burnout, promoting collaboration, and motivating both students and teachers in various educational contexts. Furthermore, collaborative filtering mechanisms, employed through gamification features, have facilitated personalized learning pathways, bridging the gap between individual needs and collaborative efforts.

5. CONCLUSION

These studies highlight the effectiveness of gamification in education, utilizing various models and technologies to enhance the learning experience.

Gamification elements such as progress tracking and badges have shown positive outcomes, while collaborative tools and standardized materials promote collaboration and content quality. Accessible and adaptable learning platforms cater to diverse devices and preferences. Despite some limitations, gamification improves student motivation and achievement. Personalization and game element integration create engaging learning environments.

In conclusion, the aforementioned studies indicate a strong connection between gamification elements and collaborative filtering algorithms in educational contexts. By integrating collaborative filtering techniques, educational applications can enhance the learning experience by personalizing content, providing feedback, and promoting engagement and motivation among learners. These findings contribute to the growing body of knowledge regarding the effective integration of gamification and collaborative filtering algorithms in educational settings.

AUTHORS' CONTRIBUTIONS

All authors collaborated to compile this scientific article as a preliminary study in the development of gamification in learning media.

ACKNOWLEDGMENTS

Authors would like to thank the research members who helped in writing this article.

REFERENCES

[1] A. Z. Rahman, H. M. Sadida, H. Okitasari, G. Chisyti, and N. Fadhilah, "Journal of Logistics and Supply Chain Development of Mobile Learning for Distance Learning in Procurement Logistics Course (Case Study : Logistic Engineering Student Program UPI)," vol. 1, no. 2, pp. 62–72, 2021.

[2] Tarnowska, K., Ras, Z.W., Daniel, L. (2020). Introduction. In: Recommender System for Improving Customer Loyalty. Studies in Big Data, vol 55. Springer, Cham. https://doi.org/10.1007/978-3-030-13438-9_1

[3] V. Bhatnagar, *Collaborative filtering using data mining and analysis*. 2016. DOI: 10.4018/978-1-5225-0489-4

[4] E. Mele, A. Tatsiopoulou, and A. Ktena, "Gamifying E-learning Course Content," *2020 9th Mediterr. Conf. Embed. Comput. MECO 2020*, pp. 8–11, 2020, doi: 10.1109/MECO49872.2020.9134195.

[5] Y. Heryadi and K. Muliamin, "Gamification of M-learning Mandarin as second language," *2016 1st Int. Conf. Game, Game Art, Gamification, ICGGAG 2016*, 2017, doi: 10.1109/ICGGAG.2016.8052645.

[6] J. P. Lopez, A. Cerezo, J. M. Menendez, and J. P. Ballesteros, "Usage of mobile devices as collaborative tools for education and preparation of official exams," *Proc. Int. Symp. Consum. Electron. ISCE*, vol. 2015-Augus, pp. 4–5, 2015, doi: 10.1109/ISCE.2015.7177809.

[7] T. Sagirani, M. J. Dewiyani Sunarto, B. Hariadi, T. Amelia, and J. Lemantara, "Prototype of Mobile Learning Application (MoLearn) by Utilizing the Gamification Concept," *Proc. 6th IEEE Int. Conf. MOOCS Innov. Technol. Educ. MITE 2018*, pp. 1–5, 2018, doi: 10.1109/MITE.2018.8747089.

[8] M. K. C. Yeh, A. Toshtzar, L. Guertin, and Y. Yan, "Using spaced repetition and gamification to enhance K-12 student science literacy with on-demand mobile short reads," *Proc. - Front. Educ. Conf. FIE*, vol. 2016-Novem, pp. 0–3, 2016, doi: 10.1109/FIE.2016.7757361.

[9] L. S. Sanjaya, Ferdianto, and Titan, "Development of gamification mobile application for students," *Proc. 2020 Int. Conf. Inf. Manag. Technol. ICIMTech 2020*, no. August, pp. 605–608, 2020, doi: 10.1109/ICIMTech50083.2020.9211283.

[10] S. P. Sarkar, B. Sarker, and S. K. A. Hossain, "Cross platform interactive programming learning environment for kids with edutainment and gamification," *19th Int. Conf. Comput. Inf. Technol. ICCIT 2016*, pp. 218–222, 2017, doi: 10.1109/ICCITECHN.2016.7860198.

[11] W. S. Yue and C. Y. Ying, "The Evaluation Study of Gamification Approach in Malaysian History Learning via Mobile Game Application," *Proc. - IEEE 17th Int. Conf. Adv. Learn. Technol. ICALT 2017*, pp. 150–152, 2017, doi: 10.1109/ICALT.2017.69.

[12] O. De Troyer, J. Maushagen, R. Lindberg, J. Muls, B. Signer, and K. Lombaerts, "A playful mobile digital environment to tackle school burnout using micro learning, persuasion & gamification," *Proc. - IEEE 19th Int. Conf. Adv. Learn. Technol. ICALT 2019*, vol. 2161–377X, pp. 81–83, 2019, doi: 10.1109/ICALT.2019.00027.

[13] M. Goel, T. Dixit, A. Bajpai, and A. Singh, "Using gamification to rationalize excessive use of mobile devices among children and adolescents," *2021 Int. Conf. Commun. Syst. NETworkS, COMSNETS 2021*, vol. 2061, pp. 634–637, 2021, doi: 10.1109/COMSNETS51098.2021.9352888.

[14] L. Ramírez-Donoso, J. S. Rojas-Riethmuller, M. Pérez-Sanagustin, and A. Neyem, "Enhancing collaborative learning in higher education online courses through a mobile game app," *Proc. 2017 IEEE 21st Int. Conf. Comput. Support. Coop. Work Des. CSCWD 2017*, no. 1, pp. 103–108, 2017, doi: 10.1109/CSCWD.2017.8066678.

[15] J. Pirker, C. Gutl, and Y. Astatke, "Enhancing online and mobile experimentations using gamification strategies," *exp.at 2015 - 3rd Exp. Int. Conf. Online Exp.*, pp. 224–229, 2016, doi: 10.1109/EXPAT.2015.7463270.

[16] R. Blunt, "Does Game-Based Learning Work? Results from Three Recent Studies.", 2007

[17] Paiva, S. (2018) Adoption of gamification strategies to promote motivation in high education teachers so they achieve better assessements, 13ª Conferência Ibérica de Sistemas e Tecnologias de Informação (CISTI 2018), Cáceres. http://doi.org/10.23919/CISTI.2018.8399447