International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

The State of Research on Effects of Gamification in the Context of Learning

Elizaveta Osipovskaya[1], Péter Tasi[2], Michael Green[3], Dusko Lukac[4]

RUDN University, Russia[1]
Aston University, United Kingdom[2]
University of Kent, United Kingdom[3]
EPLAN GmbH & Co. KG, Germany[4]

Abstract

Gamification has been promoted as a major aim in the context of learning and education. According to MarketsAndMarkets Research, the game-based learning market size is expected to grow from USD 11.0 billion in 2020 to USD 29.7 billion by 2026. This increase is attributed to the following reasons: lockdowns caused by COVID-19 pandemic, new product launches with the incorporation of Artificial Intelligence, and the continuously rising mobile internet user penetration [16]. Therefore, the potency of gamification in the current learning process is of high interest. This article systematically synthesises and brings into focus the state of research on gamification that affects behavioural learning outcomes in the higher education setting compared with conventional instructional methods. The primary research questions are: what are the learning outcomes of using game elements, what are the challenges of gamification, and what are the future research directions in this field? This literature review covered peer-reviewed empirical studies published between 2021 and 2022. Publications were required to include one crucial condition in which gamification is defined as the use of game elements in non-game contexts. The study presents the benefits of implementing gamified learning as well as the drawbacks, and highlights the various types of research gaps and state-of-the-art unresolved issues in the field of game-based learning.

Keywords: *Gamification, game-based learning, gamified learning*

1. Introduction

Today many experts agree that gamification is the future of innovation in the EdTech industry and one of the top 10 must-have features of a learning management system. The introduction of AI, Big Data, cloud technology, IoT, mobile learning, and VR have the potential to enrich gamified learning [41]. According to a 2023 report, the global gamification market is going to reach a value of US$ 43.92 billion by 2027. The report emphasises that the market is primarily driven by the widespread adoption of AI-based gamification solutions [33].

Gamification refers to the implementation of game mechanics and design elements in non-gaming environments with an enhanced focus on effective user engagement [36]. Fardo et al. [13] highlight some game features that are crucial for gamification in learning:

- Game mechanics: points, scores, ranks, levels, leaderboards, badges, trophies.
- Game dynamics: achievements, progress, competition, surprise.
- Game thinking: converting an everyday experience into an activity that has elements of competition, cooperation, and storytelling.

Gamification in education sounds like the most promising approach, but does it really improve the learning? When it comes to corporate learning, the textbook example is how *Beat the GMAT* gamifies the business school community with Badgeville. By using game mechanics like Social Fabric, *Beat the GMAT* was able to increase pages-per-visit by 195 percent, and total time spent within the MBA Watch community by 370 percent. An increase of comments within the community per month (8000), and community members who followed the schools (900) was also recorded. Beat the GMAT also implemented two different Leaderboards for each school [3]. Another inspirational example is the Deloitte Leadership Academy (DLA) training program. As learners completed each online learning program, they received a badge to mark their achievement. Most of those badges were won upon completion of competencies, but some were ‘secret’ badges, dubbed “Snowflake” badges. These were created to surprise employees and were unlocked only by gaining certain goals. Learners, who spent increased amounts of time on the site showed almost addictive behaviour. Since the integration of

gamification in DLA, there has been a 37 percent increase in the number of users returning to the site each week [27].

Gamification has also positively impacted learning in higher education, especially concerning students' engagement, motivation, academic achievement, social connectivity, feedback mechanism and knowledge retention [6, 9, 10, 21, 25, 36, 39]. Gamification undoubtedly has elevated the digital learning process for learners too.

Moreover, it is crucial to emphasise the main educational subjects where gamification has already been implemented: STEAM [23], language learning [7], healthcare [26, 38], sports [14, 15], chemistry [5], physics [35], mathematics [18, 22], astronomy [2], geography [24], environmental science [30], natural science [34], history [4, 28], and music [17].

2. Methodology

In the current study we examined the understanding of the contemporary literature on gamification in the context of higher education. We raise three primary research questions: what are the learning outcomes of using game elements; what are the challenges of gamification; and, what are the future research directions in this field? The literature was gathered by searching Google Scholar database. As recent systematic literature reviews and bibliometric studies cover the period up to 2021 we focused the research on empirical studies published between 2021 and 2022. The initial search revealed 728 articles. From these, those which were empirically evidenced studies with real-world data associated with higher education were retained. Publications that were focused on research not connected with universities (e.g. PK-12 educational setting, employee training and development) were excluded. Finally, articles that merely reported on descriptive analyses of using gamification features instead of their actual application were also eliminated. After applying the inclusion criteria, the number of included papers reduced to 13.

3. Results and Discussion

In order to answer the aforementioned research questions we conducted the analysis to identify benefits, drawbacks and future research themes in the literature devoted to gamification in higher education. There were four major benefits of gamification in educational environments identified:

1. Improves knowledge retention – the game dynamics enhance information acquisition, knowledge application.
2. Increased learner motivation and engagement – there is evidence which indicates that authentic motivation like enjoyment, enthusiasm, and happiness in conjunction with external rewards can affect the acquisition of skills, competence, and improving the understanding of scientific concepts [19, 26]. Some findings identify that students' motivation could be inconsistent. Authors conclude that game-based learning is applicable if the target group can recognize the content-related benefit, and if the educational materials are designed to be challenging [31]. However, whilst this is a major finding from several studies, it is important to recognise that gamification has also been found to have no impact on motivation and engagement [11].
3. Creates an effect of presence – when an educator designs gamified simulation scenarios that bring to life actual real-world experiences from the workplace. For instance, some authors argue that proper use of games in medical education can be a valuable tool for an instructor [26].
4. Affects learners' positive behavioural change — some findings suggest that short-term over longer-term gamified interventions might be a promising way to initiate changes in learner's behaviours and improve learning outcome [20].

While most research shows positive effects of gamification, there are papers focused on negative effects of game design elements on learning systems, and it must be admitted that there are very few studies on the subject [1, 40]. A number of harmful effects were noted by the authors, they found that badges, leaderboards, competitions, and points are the game design elements most often causing destruction and reduced learners' attention from the main focus. The most cited negative aspects were lack of effect, worsened performance, motivational issues, lack of understanding, and irrelevance. The ethical issues of gaming the system and cheating were also often reported.

Moreover, Almeida et al. [1] revealed some challenges of using Kahoot! in teaching and learning in higher education. The results indicated that students encountered technical errors such as bandwidth and a lack of experience and skills in using technology. The features of this platform negatively affected students' interest and motivation [8]. But we also found studies that proved the effectiveness of the use of Kahoot! in flipped learning [12].

Furthermore, the survey of literature reviews, scientific mapping, meta-analysis, and bibliometric studies allowed us to identify some research directions and opportunities in the field of game-based learning.

- It is unknown whether gamified educational environments are better than non-gamified ones in terms of students' experiences (e.g., engagement, motivation, flow experience, and others).
- The education community requires a greater understanding of what are the best design solutions in game-based learning regarding students' characteristics (e.g., gamer types, gender, age).
- There could be greater exploration of the potential of automation to improve the design process for gamified educational systems. It could be extremely helpful as without having to manually create personalised designs for gamified educational systems, the development team can focus on other tasks.
- Future studies could consider the possibility of conducting longitudinal study. This type of study will show how the results perpetuate or change over time [32].
- Develop evaluation tools for the use of gamification and augmented reality in the educational process.
- It is essential not only to focus on improving students' academic performance while implementing gamification but also to explore their social-emotional development and 21st-century skills cultivation [21].
- It is crucial to remember that gamified systems are not formed only by gamification elements, but several other aspects (e.g., screen components and colours). Thus, without isolating the gamification elements from these other components, it is difficult to know whether the students' perception has been influenced only by the gamification elements or by other components of the interface. In this sense, it is recommended that future studies can consider other related aspects, such as the gamification design as a whole (e.g., gamification elements colours and visual aspects, elements position (in the users' interface), the moment when the elements will appear to users, and how the elements will go when relating to system educational activities and other components' interface).
- Personalisation based on gamer types is a primary and fundamental approach to personalising gamified systems. Thus, it is recommended to conduct studies that can investigate various aspects of students' preferences for elements of gender, age, demographic data of users, and types of activities.
- Future studies may also consider whether there are elements of gamification that can better adapt to each type of educational activity, and then propose and evaluate systems that offer these aspects of personalisation [29].
- Future studies could consider whether gamification increases levels of professional competence.
- Insight into cultural differences and the impact on gamified experiences warrants further exploration [32].
- There is a need in research for carefully structured examinations and rigorous methods that validate instructional advantages of gamification [37].
- There are limitations regarding the impact of gamification on learners' behaviour. Most of the studies reviewed used diverse gamification elements, including online badges and leaderboards, and some combined with other sources such as progress bars or rewards points. Future research should aim at objective measurable treatments, e.g., online badges and leaderboards only [20].
- Future research should attempt to address issues that relate to various aspects of gamification, such as educational strategies, game mechanics, and elements. It is crucial to highlight that researchers cannot presume the effects of each gaming element alone since all studies used gaming elements in combination [19].
- There are a lot of studies devoted to the level of students' satisfaction with virtual reality technology, therefore it is essential for future research to conduct large scale surveys in order to corroborate the previous results.

4. Conclusion

A weighted conjunction of a well-structured storyline, game elements, and healthy competition bring out the best from gamification in higher education. The studies reviewed indicate that the advantages of game-based learning still outweigh the challenges involved. Education is much more entertaining

and gainful when the content is gamified. To bridge all the research gaps the academic community must conduct further studies evaluating the students' performance from various angles.
Our investigations into this area are still ongoing, but one idea should be taken into consideration. In education, gamification takes the form of metrics like exam scores, course grades, and the defence of diploma. They are considered as true values of education and without them it would be hard to measure students' progress. However, the values associated with a good education are diverse and complex, including personal transformation, the cultivation of skills, exposure of horizon. Gamification brings some relief from this complexity by providing obvious and measurable metrics for success.

References

[1] Almeida, C., Kalinowski, M., Uchôa, A., Feijó, B. "Negative effects of gamification in education software: Systematic mapping and practitioner perceptions", Information and Software Technology, 156, 2023, ISSN 0950-5849.
[2] Barringer, D.F., Plummer, J.D., Kregenow, J., Palma, C. "Gamified Approach to Teaching Introductory Astronomy Online". Phys. Rev. Phys. Educ. Res. 2018, 14, 010140.
[3] Beat the GMAT gamifies the business school community with Badgeville https://shortyawards.com/4th/beat-the-gmat-gamifies-the-business-school-community-with-badgeville, last accessed 2023/01/15.
[4] Bonacini, E., Giaccone, S.C. "Gamification and Cultural Institutions in Cultural Heritage Promotion: A Successful Example from Italy". Cult. Trends 2021, 31, 3–22.
[5] Chans, G.M., Castro, M.P. "Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students". Computers 2021, 10, 132.
[6] De Sousa Borges, S., Durelli, V.H.S., Reis, H.M., Isotani, S. "A Systematic Mapping on Gamification Applied to Education". In Proceedings of the 29th annual ACM symposium on applied computing, Gyeongju, Korea, 24–28 March 2014; ACM: New York, NY, USA, 2014.
[7] Dehganzadeh, H., Dehganzadeh, H. "Investigating Effects of Digital Gamification-Based Language Learning: A Systematic Review". J. Engl. Lang. Teach. Learn. 2020, 12, 53–93.
[8] Dharmawan Sianturi A., Hung, R-T. "The Challenges of Using Kahoot! in Teaching and Learning in Higher Education – A Systematic Review". In Proceedings of the 6th International Conference on Digital Technology in Education (ICDTE '22). Association for Computing Machinery, New York, NY, USA, 2023, 72–77.
[9] Dichev, C., Dicheva, D. "Gamifying education: what is known, what is believed and what remains uncertain: a critical review". International Journal of Educational Technology in Higher Education, 14(9), 1–36, 2017.
[10] Dicheva, D., Dichev, C., Agre, G., & Angelova, G. "Gamification in education: a systematic mapping study". Educational Technology & Society, 18(3), 75–88, 2015
[11] Donnermann, M., Lein, M., Messingschlager, T., Riedmann, A., Schaper, P., Steinhaeusser, S., Lugrin, B. "Social robots and gamification for technology supported learning: An empirical study on engagement and motivation", Computers in Human Behavior, 121, 2021.
[12] Ekici, M. "A systematic review of the use of gamification in flipped learning". Educ Inf Technol 26, 3327–3346 (2021).
[13] Fardo, M.L., Kapp, sM. "The gamification of learning and instruction: game-based methods and strategies for training and education. San Francisco: Pfeiffer, 2012. CONJECTURA: filosofia e educação, 18(1), 2013, 201-206.
[14] Fernandez-Rio, J., de las Heras, E., González, T., Trillo, V., Palomares, J. "Gamification and Physical Education. Viability and Preliminary Views from Students and Teachers". Phys. Educ. Sport Pedagog. 2020, 25, 509–524
[15] Ferriz-Valero, A., Østerlie, O., Martínez, S.G., García-Jaén, M. "Gamification in Physical Education: Evaluation of Impact on Motivation and Academic Performance Within Higher Education". Int. J. Environ. Res. Public Health 2020, 17, 4465
[16] Game-based learning market. Global forecast to 2026, https://www.marketsandmarkets.com/Market-Reports/game-based-learning-market-146337112.html (2022), last accessed 2022/12/09.
[17] Gomes, C., Figueiredo, M., Bidarra, J. "Gamification in Teaching Music: Case Study". EduRe'14 - International Virtual Conference on Education, Social and Technological Sciences; Valencia Polytechnic University: Valencia, Spain, 2014, 1–19.
[18] Jagušt, T., Botički, I., So, H.-J. "Examining Competitive, Collaborative and Adaptive Gamification in Young Learners' Math Learning". Comput. Amp Educ. 2018, 125, 444–457.

[19] Kalogiannakis, M., Papadakis, S., Zourmpakis, A-I. “Gamification in Science Education. A Systematic Review of the Literature”. Education Sciences. 2021; 11(1):22.
[20] Kim, J., Castelli, D.M. “Effects of Gamification on Behavioral Change in Education: A Meta-Analysis”. International Journal of Environmental Research and Public Health. 2021; 18(7):3550.
[21] Lampropoulos, G., Keramopoulos, E., Diamantaras, K., Evangelidis, G. “Augmented Reality and Gamification in Education: A Systematic Literature Review of Research, Applications, and Empirical Studies”. Applied Sciences. 2022; 12(13):6809.
[22] Lo, C.K., Hew, K.F. “A Comparison of Flipped Learning with Gamification, Traditional Learning, and Online Independent Study: The Effects on Students’ Mathematics Achievement and Cognitive Engagement”. Interact. Learn. Environ. 2018, 28, 464–481.
[23] López, P., Rodrigues-Silva, J., Alsina, Á. “Brazilian and Spanish Mathematics Teachers’ Predispositions Towards Gamification in STEAM Education”. Educ. Sci. 2021, 11, 618
[24] Mahat, H., Hashim, M., Norkhaidi, S.B., Nayan, N., Saleh, Y., Hamid, N., Hidayah, N., Faudzi, N.A.M. “The Readiness of Geography Teacher Trainees in Gamification Approach.” Rev. Int. Geogr. Educ. Online 2021, 11, 720–734
[25] Manzano-León, A.,Camacho-Lazarraga, P., Guerrero, M.A., Guerrero-Puerta, L., Aguilar-Parra, J.M., Trigueros, R., Alias, A. “Between Level up and Game over: A Systematic Literature Review of Gamification in Education”. Sustainability 2021, 13, 2247.
[26] McCoy, L., Lewis, J.H., Dalton, D. “Gamification and Multimedia for Medical Education: A Landscape Review”. J. Osteopath. Med. 2016, 116, 22–34.
[27] Meister, J. C. “How Deloitte Made Learning a Game”, Harvard Business Review, https://hbr.org/2013/01/how-deloitte-made-learning-a-g, last accessed 2023/01/15.
[28] Moseikina, M., Toktamysov, S., Danshina, S. “Modern Technologies and Gamification in Historical Education”. Simul. Gaming 2022, 53, 104687812210759.
[29] Oliveira, W., Hamari, J., Joaquim, S. et al. “The effects of personalized gamification on students’ flow experience, motivation, and enjoyment”. Smart Learn. Environ. 9, 16 (2022).
[30] Ouariachi, T., Li, C.-Y., Elving, W.J.L. “Gamification Approaches for Education and Engagement on Pro-Environmental Behaviors: Searching for Best Practices”. Sustainability 2020, 12, 4565.
[31] Platz, L. “Learning with serious games in economics education a systematic review of the effectiveness of game-based learning in upper secondary and higher education”, International Journal of Educational Research, 115, 2022.
[32] Rao, H. "Gamification in Higher Education: A Systematic Literature Review with Particular Reference to Octalysis as the Futuristic Framework for Further Research." ducation Services (2022): 38.
[33] Research and Markets. Gamification Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2022-2027, https://www.researchandmarkets.com/reports/5642308 last accessed 2023/01/15.
[34] Rivas, E.S., Palmero, J.R., Rodríguez, J.S. “Gamification of Assessments in the Natural Sciences Subject in Primary Education”. Educ. Sci. Theory Pract. 2019, 19, 95–111
[35] Rose, J.A., O’Meara, J.M., Gerhardt, T.C., Williams, M. “Gamification: Using Elements of Video Games to Improve Engagement in an Undergraduate Physics Class”. Phys. Educ. 2016, 51, 055007
[36] Sailer, M., Homner, L. “The Gamification of Learning: a Meta-analysis”. Educ Psychol Rev 32, 77–112 (2020).
[37] Saleh Metwally, A., Nacke, L. E., Chang, M., Wang, Y., Fahmy Yousef, A. “Revealing the hotspots of educational gamification: An umbrella review”, International Journal of Educational Research, 109, 2021.
[38] Sandrone, S., Carlson, C. “Gamification and Game-Based Education in Neurology and Neuroscience: Applications, Challenges, and Opportunities”. Brain Disord. 2021, 1, 100008.
[39] Subhash, S., Cudney, E.A. “Gamified Learning in Higher Education: A Systematic Review of the Literature”. Computers in Human Behavior, 2018, 87, 192–206.
[40] Toda, A.M., Valle, P.H.D., Isotani, S. “The Dark Side of Gamification: An Overview of Negative Effects of Gamification in Education”. In: Cristea, A., Bittencourt, I., Lima, F. (eds) Higher Education for All. From Challenges to Novel Technology-Enhanced Solutions. HEFA 2017. Communications in Computer and Information Science, 832, 2018. Springer, Cham.
[41] Vatsyayan, K. “Gamification In EdTech: The Future Of Innovative Learning”, https://elearningindustry.com/gamification-in-edtech-the-future-of-innovative-learning, 2022, last accessed 2023/01/17.