Does Gamification Influence Students' Online Learning Behaviors and Academic Performance? A Learning Analytics Perspective

Muhammad Yasir Mustafa[1(✉)], Ahmed Tlili[1], Ali Gohar Qazi[2], Ronghuai Huang[1], and Michael Agyemang Adarkwah[1]

[1] Jingshi Technology, 12F, Block A, Building, No. 12 Xueyuan South Road, Haidian District, Beijing 100082, China
Yasir@mail.bnu.edu.cn

[2] Institute of Education, University College London, London, UK

Abstract. While several studies revealed that gamification could enhance students' learning motivation and engagement, less focus in the literature has been paid to the changes that gamification might bring to students' learning behaviors. Motivated by this research gap, this study harnesses the power of big data and learning analytics (LA) to analyze and compare students' learning behaviors in gamified and non-gamified learning environments. This study first develops a Gamified Learning Management System (GLMS) based on the self-determination theory (SDT). It then analyses the students' learning behaviors on it and compares them to a non-gamified version of it. Involving 204 students who used the two LMSs to learn the Human-Computer Interaction course were divided into two experimental groups. The findings revealed a positive and significant correlation between gamified earning points, students' final grades, and increased student engagement, The implications of this study suggest that gamification could be a practical approach to enhance students' academic performance and engagement in online learning environments.

Keywords: Gamification · self-determination theory (SDT) · student engagement · learning analytics · big data · academic performance

1 Introduction

Higher education institutions are adopting digital transformation techniques to transition from traditional to e-learning education systems but face ICT and operational risks. Most universities worldwide use e-learning systems to facilitate interaction between students and teachers while minimizing time and space constraints to promote active learning. In particular, the COVID-19 pandemic has encouraged teachers to encourage their students to use learning management systems (LMSs) more actively. LMSs are generally used by the majority of educational institutions to handle their courses online (Alturki and Aldraiweesh 2021), storing rich educational data in the LMS server, which acts as a repository. However, in most cases, students do not fully understand the lecture

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 127–138, 2023.
https://doi.org/10.1007/978-981-99-5961-7_14

uploaded on the LMS, leading to several queries the teacher must respond to. Despite the availability of LMS, their capabilities are not always fully utilized.

To address this issue, we observed the traditional LMS (TLMS) at one of Pakistan's public sector universities was observed to develop a Gamified Learning Management System (GLMS) using game design elements and principles. This paper presents the study's findings, which aimed to explore how gamification can improve lecture comprehension and investigate the effects of gamification on students' learning activities in LMS. The first objective of this research was to create a system that improves student engagement, promoting learning activity by attracting students to the system and improving student-teacher interaction. The developed LMS will advance existing TLMS by encouraging its users through points, badges, levels, rewards, and competitive features that will encourage the students to perform to their best potential. Following the design and development of the gamified system, the research seeks to explore how the students' activities within the GLMS relate to their academic achievement. The study's second objective was to assess students learning behavior by applying learning analytics to the data produced by GLMS. Thus, the following research questions guided the study:

1. What are the key design elements of the Gamified Learning Management System (GLMS)?
2. What is the relationship between studying on the GLMS and the academic performance of students?

2 Theoretical Background

2.1 Gamification and Game Elements

Gamification has become a common concept in recent years, covering many fields, such as education. The concept does not assume that games are developed, but the game mechanics and elements are used in non-gaming contexts to engage and motivate users, promote learning, and solve problems (Enders, 2013; Kapp, 2012). Mechanics and elements are the features of the game, a collection of instructions, rules, and feedback mechanisms that create an enjoyable experience (Enders, 2013). Non-gaming contexts mean it is not like the actual game but the use of game rules. Werbach (2014) stated, "Each added game element should have a playful intention to be called gamification." Several gamification design frameworks have been proposed in the literature to gamify learning environments. For example, Werbach and Hunter (2012) suggested a "framework that relies on six gamification steps, called 6D, and contains 30 game elements".

Additionally, Machado et al. (2018) put forth the GAME framework, which comprises 52 game elements categorized according to user types. Specifically, this framework is based on the self-determination motivational theory, the most crucial theory related to gamification research (Rapp et al. 2019). The game elements suggested in the 6D and GAME frameworks share some commonalities, according to Toda et al. (2019). In conclusion, eight-game elements are widely used in the 6D and GAME frameworks. However, the elements used in the proposed LMS are described in the methodology section.

2.2 Gamification's Effects on Academic Performance

Many studies in the literature emphasized that gamification might improve academic performance. Oliveira et al. (2021) "found an 80% increase in student's motivation and further a significant relationship was recorded between student profiles and the results obtained by incorporating gamification". According to (Barata, Gama, Jorge, Gonçalves, & Goncalves 2013), gamifying a Master's-level college course with badges, leaderboards, challenges, and points can increase student participation and attendance. A study by Ramírez (2020) found a positive effect of gamification on students' academic performance. In an empirical study conducted at an Asian institution, Hew et al. (2016) showed that points, badges, and leaderboards significantly impacted student motivation and engagement to participate in more demanding tasks. Akron Glu et al. (2017) demonstrated that quests, leaderboards, points, reputation, and virtual gifts boost students' engagement, attendance, and motivation in course activities.

2.3 Feedback

"Feedback" is the most effective instructional strategy for enhancing learning and increasing accomplishment (Latifi et al. 2021), but depending on its effectiveness and timing, its impact may be either beneficial or detrimental. While there is a long history of research on feedback in educational settings, it is commonly acknowledged that feedback is understood to be cognitive as well as constructive information that is given to a student and also the process by which the student makes sense of the received information to enhance learning and close the gap between their current performance levels and desired levels (Shute 2008).

In this study, feedback is viewed as a teaching and learning activity that teachers and students may carry out to enhance learning in educational contexts, including contexts in higher education. A Gamified Feedback approach was introduced in the GLMS to allow the teacher to obtain timely feedback on the lecture, enhance student comprehension, and reduce the interaction gap between the teacher and students.

2.4 Learning Analytics

Learning analytics is a fast-increasing field of Technology-Enhanced Learning (TEL) research. Its origin dates back more than 15 years. In fact, since 2008, the concept of analysis in education began to gain the attention of researchers with a focus on understanding, enhancing, and optimizing the learning and teaching process. In 2010, the concept of Learning Analytics (LA) was separated from the area of analytics and became an independent field.

With gamification, learning analytics is a crucial area that views the information produced by learning systems (Tlili et al. 2017). In this study, the LA was used in both TLMS and the proposed GLMS to track the students' activities and visualize students learning behavior.

2.5 Learning Analytics and Feedback

The effectiveness of feedback also depends on the quality and how it is conceived and applied by students and its timeliness (Er, Dimitriadis, and Gašević 2021). There is evidence from several studies that Learning Analytics (LA) can facilitate giving students' valuable feedback promptly. In summary, existing literature reveals that LA can offer significant practical support for feedback practices (Er et al. 2021), and it has been suggested that LA should therefore be an essential component of feedback design in data-rich environments (Er et al. 2021). Therefore, this study incorporated the LA analytics to enrich the feedback system and track and access the learning activities in Gamified and traditional LMS.

3 Methods

A GLMS was designed to engage and motivate the students in their Learning process. A self-determination theory (SDT) was used to design the main structure of GLMS. However, we discussed the existing LMS, the proposed design, and the game design elements selected to gamify the LMS. This section provides a detailed overview of the gamified system components. Furthermore covered is the relationship between gamification and academic achievement.

3.1 Gamified LMS and Self-determination Theory

As discussed earlier, using the self-determination theory, GLMS was developed in response to traditional LMS (TLMS) at one of the public sector universities in Pakistan. GLMS was then used to deliver a course to the three sections of BS (Computer Science) students. The students were familiar with the Traditional LMS because they had previously used it at the university in non-gamified settings. The same teacher provided all of the material. Weekly materials in various formats, including videos, pictures, texts, PowerPoint presentations, and external links to web resources, were added for each section. Activities and quizzes that could be completed individually or in groups were included in each course to assess the student's knowledge. To have a successful GLMS should promote students' enjoyment and motivation. Our implemented game elements had to meet the different psychological needs of learners. In light of this, the self-determination theory (SDT) was successfully applied in games while designing GLMS. This theory is founded on three basic psychological needs—competence, autonomy, and social relatedness—that promote enjoyment (Ryan, Deci University, and Rochestu 2004) (Table 1).

Table 1. Game elements used to design GLMS

Psychological needs	Game elements	Matching psychological needs to game elements
Competence	Activity Points Badges Leader board Levels Feedback	"Feedback that shows students' contributions" "Feedback that shows students' achievements" "Feedback that shows students' performance." "Feedback that shows students' expertise." "Feedback that shows students' performance."
Autonomy	Avatar and customization Badges	"Students can freely choose their visual representations within the gamified courses." "Students can display or hide their awarded badges on their profiles."
Social relatedness	Forum discussion	"Students can interact and collaborate to complete a given goal."

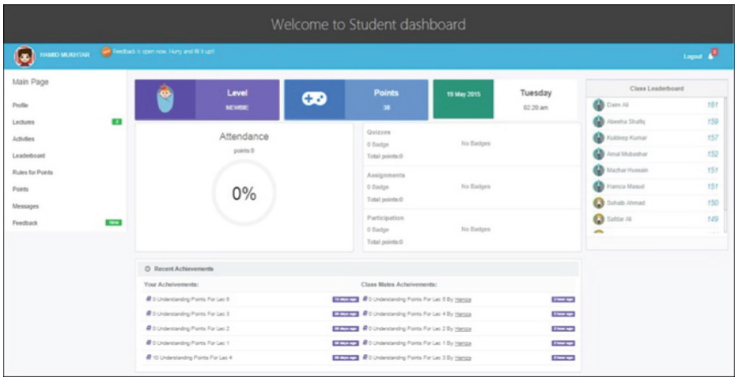

Fig. 1. Gamified LMS

Though (SDT) is previously validated by (Tlili et al. 2017). The results showed a substantial difference between the student's intrinsic motivation levels before and after using the GLMS. This confirms the significance of the designed GLMS and self-determined environment to increase students' intrinsic learning motivation. The Existing features of LMS, like quizzes, assignments, grading, discussions, material, discussion forum, and functions of the LMS, were enriched by incorporating the Game elements and game features. A screenshot of the GLMS is shown in Fig. 1.

The main features and game elements used in GLMS are given below:

(1) **Activity Point:** The Gamification point system in LMS offered more points to specific actions or activities. The points system was customized and added to the leaderboard to increase students' engagement in their learning processes (Zichermann & Cunningham 2011).
(2) **Badges:** The Badges were incorporated to provide students with a target to inform them of what they've achieved Enders and Kapp (2013) within the LMS meaningfully. Teachers were authorized to choose their design and to allocate badges to anything they wanted – for instance, completing an assignment or a series of tasks. Such badges serve as a source of pride and inspiration for learners, and they can be exchanged to improve competitiveness through social media.
(3) **Leader board:** The leader board was used as a visual way to track progress through various activities for a positive emotion that they had a chance of winning (Alaswad & Nadolny 2015). Students were allowed to check their progress against classmates, promote competition and drive them to work harder.
(4) **Levels: Levels** were used to see at what level (Newbie, Mediocre, and Expert) students are. The level was decided according to the no. of activities students performed on LMS. Simoes et al. (2013) recommended this to match the students' new skills. Each week, students were challenged to complete the activities to earn the points to advance to the next level.
(5) **Feedback System:** A feedback system was used against all tractable activities. Teachers at GLMS gave students amusing weekly comments to assure their psychological stability and further motivate them while learning (Edmondson 1999). Considering each student's performance during the course, the teacher wrote the feedback (e.g., based on the number of accumulated points or collected badges). There was also a visual input for activities that needed to be accomplished, what is finished, what percent of the entire task is reached, how many points students have and on what stage students are at, etc.
(6) **Avatars and customization:** Different avatars were used as a game element to increase the feeling of emotional attachment, resulting in a better level of engagement (Dunn & Guadagno, 2012). Avatar is the user's graphical image or alter ego or character of the user. An object or symbol that represents a given person in a game world. Students were allowed to modify their avatar profile, personal information, and the position of the elements. Those elements can be shifted around and made accessible on request.
(7) **Discussion Forum:** The discussion forum discussed the issues related to the lectures and essential concepts. The points were awarded according to the level of discussion by the students. It was used to engage and motivate the users and to enhance their learning through discussion.

3.2 Research Design and Intervention

Regarding the intervention, 204 fourth-semester BS Computer Science students taking the Data Structure" course tested the developed system for five weeks. Two groups of students were formed. Group B, which included 100 students, served as the control group. Group A, which included 104 students, served as the experimental group. During the five weeks of the experiment, Group A (the experimental group) used the GLMS,

while Group B solely used the TLMS. The teacher uploaded lectures in the GLMS in the same manner as in the TLMS. Since the GLMS system was utilized for five weeks, a total of 250 points was calculated for all of the activities, leading to the employment of five levels.

3.3 Sample and Data Collection

The data-collecting phase is essential since it supplies information from the GLMS that could be used for analysis and evaluation. The GLMS is set up such that activity logs can be used to track students' online activities. Each activity a student engaged in while using the GLMS was recorded in this activity log. Following the main objective of this study and the comparative analysis method employed for logs between traditional and GLMS, the following six types of activities were noted: login, Lecture View, Understanding Submitted, Page Visited, And Message Read And Profile Change. Every activity includes characteristics that give a thorough description of that activity. The characteristics of these observed activities are described as (1) Students: Student who has performed the activity, (2) Activity type: Type of activity from the six types, (3) Activity name: Name of specific activity, (4) Date: The date on which activity is performed, (5) Start time of activity, (6) End time: Time at which activity ended. Activity name gives a more precise representation of the activity. For instance, depending on the lecture number a student has viewed, an activity of type "lecture view" may have a different activity name.

The TLMS was based on Moodle framework. Moodle can record activity logs in LMSs that can be kept and used for additional research. The TLMS and GLMS log files from March to July were stored and further examined to analyze and interpret the data.

3.4 Results

A total of 7,200 events for "Group A" from the Gamified LMS and 3,151 for "Group B" from the TLMS were recorded in the activities log and saved throughout the collecting phase. A SPLUNK Tool was used to analyze the events further and gain access to log files. SPLUNK is a collection of log search and analysis components that help with thorough monitoring/Tracking of machine-generated data and gives a thorough visual analysis of log data (Balaji, Karthik Pai, Bhat, & Praveen 2021). The students' various actions were observed and analyzed using the activities log. This made it possible to analyze the events and log data more deeply. When the lecture was uploaded, student lecture views were evaluated and compared for both groups to analyze the activities of students in the Lectures component. Figures 2, 3, 4, and 5 show the traditional and Gamified LMSs' lecture views for the four lectures compared. The x-axis depicts the date, while the y-axis displays the number of events. When compared to TLMS, it can be seen that GLMS had a higher number of views on the day the lecture was uploaded. We may conclude that adding gamification to the Lectures component increased the number of views and downloads of lectures even before they were uploaded. Students used GLMS more frequently than TLMS to view lectures in this approach.

Table 2 displays the total number of views for Group A (Treatment group) and Group B (Control group) on the first day of lecture upload. It demonstrates that more lectures were viewed in the GLMS on the first day than in the TLMS.

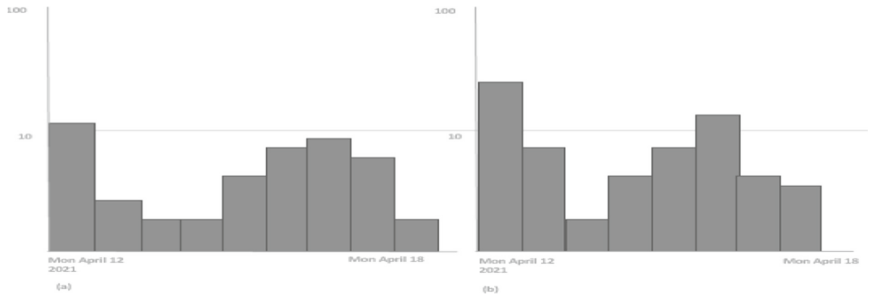

Fig. 2. Views on Lecture 1 in both (a) T LMS and (b) G LMS

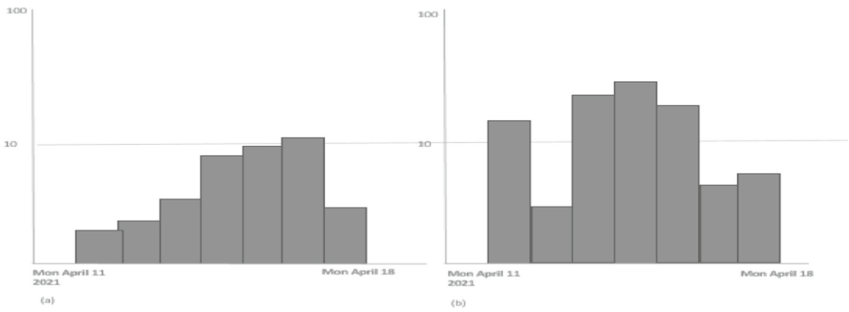

Fig. 3. Views on Lecture 2 in both (a) T LMS and (b) G LMS

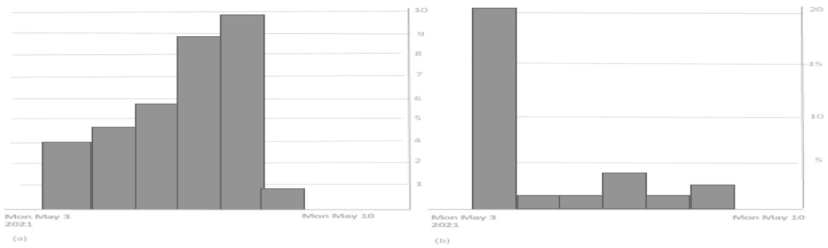

Fig. 4. Views on Lecture 3 in both (a) T LMS and (b) GLMS

Another significant finding was related to the forum discussion and the views on LMS. The more engaged students on the LMS had higher grades on the relevant test and exam when forum discussion was mapped to individual students' monthly test and end-of-semester exam marks. The top students in the class and leaderboard achieved high marks. As a result, we might assume that students' more significant participation in GLMS forums affected their academic achievement.

3.5 Analysis of Understanding Component

We used bivariate Pearson correlation analysis to thoroughly investigate the comprehending lecture component of GLMS, which is the most significant component of GLMS

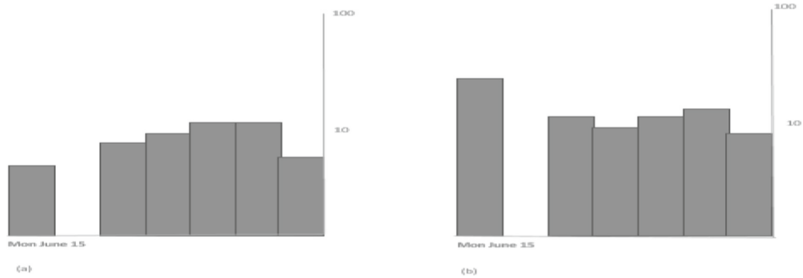

Fig. 5. Views on Lecture 4 in both (a) T LMS and (b) GLMS

Table 2. No. of lectures viewed by groups A and B on the day the lectures were uploaded

Lecture#	Views by Treatment Group-A	Views Control Group B
Lecture 1	41	15
Lecture 2	21	3
Lecture 3	32	2
Lecture 4	37	7

in gamification. We used Pearson correlation to determine the relationship between students' final grades and their understanding points recorded on GLMS. This relationship will enable us to predict how the understanding component of the GLMS will be evaluated.

Bivariate Pearson Correlation

Students from group A were considered, and their understanding points and final grades were considered for Pearson correlation analysis since GLMS was tested on group A. Students who report their understanding of lectures receive understanding points in the GLMS. As a result, we use the students' GLMS understanding points as our first variable. We use the final grades students earned in class as the second variable to find the relationship between the students' understanding points and grades. Since Pearson correlation only works with continuous variables, we translated student grades into the total points earned by the semester's conclusion.

We used the IBM SPSS tool for a Pearson correlation (2-tailed) test on log files, utilizing the students' grade points and GLMS understanding points as the main variables of interest, as shown in Table 3. The first variable is the number of understanding points that students have, which are represented by underscores; the second variable is the number of grade points that they have, which are their final grades after converting the grades they received at the end of the semester; and N represents the number of students whose data were recorded from group A.

The Students' grade points and understanding points have positive Pearson coefficient values, indicating a positive relationship. There is a significant relationship between students' grade score and their understanding points on the GLMS, as indicated by the

Table 3. Results of the Pearson relationship between grade points and understanding points for students

		Grade-Points	Understanding Score
Grade points	Pearson Correlation Sig. (2-Tailed) N	1 104	.381 .018 104
Understanding scores	Pearson Correlation Sig. (2-Tailed) N		1 104

$p < 0.05$

significance coefficient value (Sig.), which is 0.018 and less than 0.05. As a result, we can conclude that there is a significant and positive association between students' grade points and their levels of understanding. This indicates that the students who submitted their lecture understanding assignments on time and earned high understanding points are displayed to have matching high grades in class at the end of the semester.

4 Conclusion and Implications

This study presented the design of a GLMS and the game components used to encourage students to use the LMS, ensure improved student involvement, and foster competition among students. Together with the gamified components, the game features integrated with the point system are covered in detail. During the four weeks the system was used for a course at the university, the Learning Analytics revealed increased student participation and inspired them to comprehend the lecture as soon as possible after it was delivered.

Any built system can continuously be improved; hence the GLMS will likely undergo future modifications and upgrades. LMS can be gamified in various ways to improve student participation and engagement, which may impact their learning. By letting the students choose how much of the lecture slide or what portion they have understood, their comprehension can be more precise. This will enable the teacher to deliver material more precisely. The completion and level of understanding of programming exercises can be used to demonstrate the student's progress, which also calls for active participation from the teachers. At the end of the semester, top scorers on the leaderboard can also receive various awards and present to encourage them to engage with the gamified classes more regularly.

References

Alturki, U., Aldraiweesh, A.: Application of learning management system (LMS) during the covid-19 pandemic: a sustainable acceptance model of the expansion technology approach. Sustainability (Switzerland) (2021). https://doi.org/10.3390/su131910991

Balaji, N., Karthik Pai, B.H., Bhat, B., Praveen, B.: Data Visual. Splunk Tableau: a Case Study Demonstr. J. Phys: Conf. Ser. (2021). https://doi.org/10.1088/1742-6596/1767/1/012008

Barata, G., Gama, S., Jorge, J., Gonçalves, D., Goncalves, D.: Engaging engineering students with gamification an empirical study. games and virtual worlds for serious applications (VS-GAMES). In: 2013 5th International Conference (2013)

Boud, D., Dawson, P.: What feedback literate teachers do: an empirically-derived competency framework. Assess. Eval. High. Educ. (2021). https://doi.org/10.1080/02602938.2021.1910928

Carless, D., Winstone, N.: Teacher feedback literacy and its interplay with student feedback literacy. Teach. High. Educ. (2023). https://doi.org/10.1080/13562517.2020.1782372

De Oliveira, M.S., Leal, F., De Pinho, A.F., Montevechi, J.A.B.: Analysis of the relationship between student profiles and the results obtained in a university course gamification study. Int. J. Innov. Learn. (2021). https://doi.org/10.1504/IJIL.2021.118871

Díaz-Ramírez, J.: Gamification in engineering education – an empirical assessment on learning and game performance. Heliyon (2020). https://doi.org/10.1016/j.heliyon.2020.e04972

Enders, B.: Gamification, Games, And Learning: What Managers and Practitioners Need to Know. The ELearning Guild (2013)

Er, E., Dimitriadis, Y., Gašević, D.: Collaborative peer feedback and learning analytics: theory-oriented design for supporting class-wide interventions. Assess. Eval. High. Educ. (2021). https://doi.org/10.1080/02602938.2020.1764490

Gašević, D., Dawson, S., Rogers, T., Gasevic, D.: Learning analytics should not promote one size fits all: the effects of instructional conditions in predicting academic success. Internet High. Educ. (2016). https://doi.org/10.1016/j.iheduc.2015.10.002

Gaylard Baleni, Z.: Online formative assessment in higher education: its pros and cons. Electron. J. E-Learn. (2015)

Hew, K.F., Huang, B., Chu, K.W.S., Chiu, D.K.W.: Engaging Asian students through game mechanics: findings from two experiment studies. Comput. Educ. (2016). https://doi.org/10.1016/j.compedu.2015.10.010

Kapp, K.M.: What is gamification? In: The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education (2012). https://doi.org/10.1145/2207270.2211316

Latifi, S., Noroozi, O., Talaee, E.: Peer feedback or peer feedforward? Enhancing students' argumentative peer learning processes and outcomes. Br. J. Educ. Technol. (2021). https://doi.org/10.1111/bjet.13054

Machado, R.S., Oliveira, I.,Ferreiram, I., das Neves, B.H.S., Mello-Carpes, P.B.: The membrane potential puzzle: a new educational game to use in physiology teaching. Adv. Physiol. Educ. https://doi.org/10.1152/advan.00100.2017

Melnyk, T., Volchkova, H.: LMS Moodle Use Experience During Distance Learning In Higher Education Institutions. Academic Notes Series Pedagogical Science (2021). https://doi.org/10.36550/2415-7988-2021-1-192-106-111

Ryan, R.M., Deci Unwersity, E.L., Rochestu: Overview of self-determination theory: an organismic dialectical perspective. In: Handbok of Self-Determination (2004)

Shute, V.J.: Focus on formative feedback. Rev. Educ. Res. (2008). https://doi.org/10.3102/0034654307313795

Tlili, A., Essalmi, F., Ayed, L.J. Ben, J., Kinshuk, M.: A smart educational game to model personality using learning analytics. In: Proceedings - IEEE 17th International Conference on Advanced Learning Technologies, ICALT 2017 (2017). https://doi.org/10.1109/ICALT.2017.65

Werbach, K.: (Re)defining gamification: a process approach. In: Spagnolli, A., Chittaro, L., Gamberini, L. (eds.) PERSUASIVE 2014. LNCS, vol. 8462, pp. 266–272. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-07127-5_23

Werbach, K., Hunter, D.: For the Win: How Game Thinking Can Revolutionize Your Business - Kevin Werbach. Wharton Digital Press, Dan Hunter - Google Libros (2012)

Wisniewski, B., Zierer, K., Hattie, J.: The power of feedback revisited: a meta-analysis of educational feedback research. Front. Psychol. (2020). https://doi.org/10.3389/fpsyg.2019.03087