Reaching Student Engagement by Balancing Gamification and Challenges in Minor Serious Gaming

Ton Spil and Peter Hagenaars
University of Twente, Enschede, The Netherlands

a.a.m.spil@utwente.nl
p.c.a.hagenaar@utwente.nl

Abstract: This study originated from a Senior University Teaching Qualification on student engagement that withstanding many efforts on problem and challenge based education still is a concern. Within the minor Serious Gaming, third year students (n=35) where studied with mixed methods with the main question how to improve student engagement with challenges in serious gaming? First, a systematic literature study led to a new definition of student engagement: Student engagement is a multi-faceted concept that involves the interplay of various factors, including behavior, motivation, challenges, and autonomy. Then a pretest was done with last year's teaching team, a motivational survey and general evaluation survey was done and a focus group with group representatives was created. This led to two main interventions, a gamified business modelling workshop and direct feedback loops. From a gamification point of view, rewards are the best intervention but we could not implement them in this year's course. The value of this study is in understanding the complexity of student engagement. Improvement of engagement is possible with gamification, challenges and direct feedback. This study confirms that a high autonomy leads to a high engagement, future study has to be done with courses with low autonomy.

Keywords: Serious Gaming, Student Engagement, Gamification, Challenge-Based Learning, Higher Education

1. Introduction

Gamification is a new approach to learning that is not applied too often. Still, the underlying principles like feedback and rewards are long established teaching approaches (Yu, 2022). There is an international concern about student engagement among young adults (Petersen et al, 2021). Their results revealed a significantly higher user engagement with use of gamification. Hamari et al. (2016) conclude that engagement directly influences learning. Challenges in a game or gamification can positively influence the engagement. Aguilar-Cruz (2022) confirms this and also concludes that socio cultural aspects influence the learning. Yu et al (2020) also found gamification contributing to both student satisfaction and engagement, it can foster students engagement (Breiki & Yahaya, 2022). Engagement plays a key role in user's behavior and overall efficacy of goal or task-oriented behavior within computer-based environments (Psaltis et al, 2018). The main research *question* is:

How to improve student engagement with challenges in serious gaming?

2. Background

Table 1: Categories found in literature study

	Pedersen Et al, 2021	Dharwaman Et al, 2022	Khaldi Et al, 2023	Mohanaran And Srithiran 2022	Hamari Et al, 2016	Fitz Walter Et al, 2014	Psaltis et al, 2018	Yu Et al, 2020	Butler & Ahmed 2017	Rebelo Et al 2019	Zadeja And Bushati 2022	Hart Et al 2017
Challenges	X	X	X	X	X							
Behavior						X	X					
Motivation								X				
Gamification								X	X	X	X	
Autonomy				X								X

As educators navigate the complex landscape of education, they are confronted with multifaceted challenges that impact student motivation, behavior, and engagement. Through the strategic integration of gamification and the promotion of autonomy, educators can address these challenges by creating dynamic learning environments that inspire curiosity, foster collaboration, and empower students to become active participants in their education. In table 1 an overview is given of the systematic literature study.

2.1 Challenges

Challenges and gamification offer innovative approaches to enhance student engagement and motivation in the classroom, but they also present unique challenges for educators to navigate. The challenge is that engagement, also in the context of serious games, is a complex subject, as it encompasses various related concepts related to the user experience, including e.g. immersion, presence, flow, transportation, and absorption (Pedersen et al, 2021). The findings of Dharwaman et al (2022) indicate that an entrepreneurial simulation game, based on real challenges in a business environment, allows students to develop their self-efficacy, motivation, and engagement. Khaldi et al (2023) combine problem based learning elements with gamification and show that this is a powerful concept to increase learning. Mohanarajah and Sritharan (2022) show that programming is challenging in itself and that gamification is very helpful to create a flow. that the Computer Science students who played Shoot2Learn gained statistically significant improvements in learning conditional branching. Challenging components can be increased in an educational game since they can improve student engagement (Hamari et al., 2016)

2.2 Behavior

Behavior and student engagement are crucial components of a productive learning environment. Behavior refers to the actions and conduct of students, while engagement pertains to their involvement, interest, and active participation in the learning process. Fitz Walter et al (2012) study engagement on three levels, goals, sensing and game elements. Engagement is a multifaceted phenomenon with different dimensions, i.e., behavioral, cognitive, and affective (Psaltis et al, 2018). They conclude that the use of games with different degrees of challenge triggers different levels of engagement.

2.3 Motivation

Gamification offers a promising avenue for enhancing student motivation and engagement in the classroom. A student can be motivated by internal or external means. Intrinsic motivation is associated with learning something for personal pleasure or interest (e.g. playing games or creating games for fun), whereas extrinsic motivation is derived from external factors such as promised job opportunities and/or high salary scales (Ryan & Deci, 2000). Yu (et al, 2000) show that motivation is the most mentioned keyword within gamification and student engagement. In their literature study they conclude that most educational games could improve student motivation in game-based learning.

2.4 Gamification

Gamification has emerged as a powerful strategy for enhancing student engagement in the educational setting. Butler and Ahmed (2017) conclude that gamification is key in changing the learning experience for Computer Science students and will help them achieve their learning goals. Gamification is often depicted as a significant instrument to drive engagement, behavior change, and loyalty, which can be of great significance to online learning (Rebelo et al, 2019). This paper adopts one of the most popular definitions of gamification, which was proposed by Deterding, Khaled, et al. (2011, p. 1): gamification is the “use of game design elements in non-game contexts. Rebelo et al, 2019 mention the most commonly used gamification elements are:

Levels (73%);

Questions and challenges (67%);

Progress bars (67%).

On the contrary, the less used ones are leader boards (20%), badges (13%), and other tools (13%), including virtual currencies, virtual goods, and countdown clocks. Yu (et al, 2020) add feedback as a

gamification element. Gamification helps students gain motivation towards studying, and because of the positive feedback they get pushed forwards and become more stimulated to learn (Zadeja &Bushati 2022).

2.5 Autonomy (Self-efficacy)

Autonomy plays a crucial role in fostering student engagement by empowering learners to take ownership of their education and learning experiences. "Self-efficacy refers to an individual's belief in their own competence to carry out a specific task (Bandura, 1997). High self-efficacy increases the student's persistence at relevant tasks and helps them to be resilient and recover their motivation even after absolute failures. Research makes it clear that learning programming is challenging, and a learner needs high determination, dedication, and persistence. Students need to be intrinsically motivated to stay focused on learning. Self-efficacy plays a key role in keeping one's intrinsic motivation" (Mohanarajah & Sritharan, 2022). Hart et al (2017) show that situational relevance and authenticity are very important when using gamification to lever engagement.

2.6 Student Engagement

Student engagement is handled in all papers found in the systematic literature study. Therefore, we have not placed it in table 1 but see it a s an overall concept of the study. In all 12 papers found, the concept is not clearly defined. From this study we define it as: *Student engagement is a multi-faceted concept that involves the interplay of various factors, including behavior, motivation, challenges, and autonomy.* There has to be a balance between all these elements.

3. Method

This study followed a mixed method approach in which both qualitative and quantitative data were used to establish the effect of the interventions. For the literature study Wolfswinkel (et al, 2015) is used with the following search string: (serious gam*) AND (student engagement) AND (skills and challenges).

The empirical study was done from September 2023 until November 2023 for a period of 10 weeks. During the minor, the attendance on Tuesday morning 8.45 will be measured every week.

Before this period a short survey is send to last year's study to confirm the study gaps observed by the researcher. Two expert interviews were done with colleague that is also half responsible for the minor and a student assistant of 2022. They observed exactly the same gaps as the researcher observed.

During the period an intervention is done in week three, six and nine all students (n=35) are questioned on motivation of the task then at hand with the situational motivation scale (Guay et al, 2000). The questionnaire is derived from Deci and Ryan (2000). The Intrinsic Motivation is measured opposed to the Amotivation where the students have no sense of autonomy or control. The Identified Regulation (student control) is measured opposed to External Regulation (teacher guidance).

4. Results

In total 35 students enrolled in the Minor of the Business Information Technology that is accessible for every faculty and participated in this study. These students were divided over 7 project groups from 7 different programs. This course has many challenges for the student groups starting with a redesign of an existing serious game in the first three weeks. They have to apply new literature directly in creating a new operational version of an existing game. The main challenge starts in the fourth week when they start from scratch with the UN sustainability goals and create a new serious game within seven weeks. During the ten weeks many small interventions were done. The first intervention was directed at this study itself with the question how they would be motivated more? From the answers we decided to have a second intervention with a gamified workshop on business modeling, a subject they did not master yet.

Each week a headcount was done at the same moment on Tuesday morning 8.45 when a lecture was announced and performed (table 2). As expected from the peer preview the headcounts show a dip in week 3 and week 6 (shown in red). In week 4 we did an intervention with a gamified workshop which was a success (both in headcount and in evaluation. In week 7 we did not do an intervention but decided to start 45 minutes later with presentation without announcing it. We counted 16 students arriving "late"

and 12 students were on time (shown in red). In week 9 we did not do an intervention because the students needed time to finish their prototypes for the last test explaining the last low attendance in red.

Table 2: Headcount per week (n=35)

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
26	21	14	31	32	13	12	19	14	27
8.45AM	8.45AM	1st motivational survey	Intervention presentation	Thursday	2nd survey plus focus	8.45AM 28 at 9.20AM	25 at 9.20	Working session	Final presentation

The first survey was done in the third week with 20 students replying (n=20) and shown in table 3. The intrinsic motivation was higher (5.29 on a scale of 7) than anticipated from the headcounts and the peer reviews beforehand. The identified regulation was a bit lower than expected (4,94 on a scale of 7) but still positive. The external regulation was found quite high (4,07 out of 7) and the Amotivation was low (2,41 on a scale of 7). The Self-determination Index (SDI)(= 2 x IM + 1 x IR – 1 x ER – 2 x A) for the first survey was 6.63.

Table 3: First Survey in third week (n=20)

Intrinsic Motivation (IR)	5,29
Identified Regulation (ID)	4,94
External Regulation (ER)	4,07
Amotivation	2,41

In week six the survey was repeated while the students were busy with their second assignment (n=27). In general there is a negative tendency although the absolute figures are still quite high (table 4). The intrinsic Motivation (IR) dropped .64 to 4,65 out of 7. The Identified Regulation had a very minor drop (.14) but when question 6 is studied it shows an increase of "students that think the assignment is good for them" (.47). The External Regulation rises .38 but question 11 shows a big rise (1.03) which means that the have a higher feeling of obligation although nothing in the course is obliged except for the exam and the presentations. Finally Amotivation rose a little bit (. 31). The Self – Determination Index (SDI) = 4.22 (2.41 lower than the first survey)

Table 4: Second survey in sixth week (n=27)

Intrinsic Motivation (IR)	4,65
Identified Regulation (ID)	4,80
External Regulation (ER)	4,45
Amotivation	2,72

In week 6 we did two other interventions. First, we let student groups present gamification solutions to raise their own motivation. Secondly, we created a focus group of seven representatives from each group and organized an informal lunch evaluation.

Nearly all groups mentioned rewards as a possible gamification solution. The rewards came in many different way. Free, good coffee came second and cookies third. Fourth suggestion came from two groups to do quizzes to prepare for final trivial pursuit exam and combine that with rewards as extra time and bonus points.

The evaluation was rather positive and the main negative point was lack of structure but that was balanced out by the main positive point, the amount of freedom (autonomy). One group representative called the course "nearly perfect". Communication can still be improved and also the relationship between theory and practice can be improved.

The overall result of the official evaluation was very high with an average of 8.0 for the course (last year this was 7.5). The struggle between student autonomy (many students like the freedom that comes with the course) and teacher guidance (some students ask for more structure) becomes clear in this evaluation.

5. Analysis

The main challenge that we gave the students was to bring an idea for a game that arose from the group to a full implementation of a serious game. Dharwaman (2022) showed that this concept can deliver student autonomy, motivation and engagement but our measurements show more nuanced results. Although in general positive, the Extrinsic Regulation seems to lower the sense of autonomy. This means that balancing these factors becomes very important. Ideally, the students would create their own challenges.

Mohanarajah & Sritharan (2022) emphasize the importance of self-efficacy for the students within the course. Within the minor Serious Gaming that was studied we saw a high sense of autonomy but although we anticipated that the amount of freedom would rise in the second assignment because they could make their choices themselves it actually went down as mentioned in the first paragraph. Next to gamification we think that giving the students a role in designing the study and really listen to them helped in the first stage to get the sense of autonomy on such a high level.

Feedback, according to Zadeja & Bushati (2022), is a powerful (gamification) tool to engage students. Our last interventions were personal feedback loops with the groups and were received very positively. We took the students out of their normal accommodation and therefore literally out of their comfort zone to give very specific feedback on their serious game so far. It can explain the raise of External Regulation in the final survey as this feedback was announced in week 6, the week the survey was done. We confirm the work of Yu (2022) that feedback is an important part of gamification and of education in general and levers student engagement. It is strange that the intrinsic motivation drops a little bit in the second survey. Our explanation is that it is very high in the first survey, so absolutely it stays high and we had the expectation that without intervention it would drop much more.

Within the 2023 run of the course serious gaming we were not able to implement all gamification possibilities that were found. The gamified workshop we implemented proved to be a stimulus for attendance and from the general evaluation we derive a positive mention of several students. Although the feedback we gave is not necessarily a gamification instrument, the use of it was very positive toward student engagement. We feel it is the combination of gamification with other educational interventions that is the real challenge to this study.

6. Conclusions

Challenges are the most important engagement element considering gamification and serious games. Challenge Based Learning in combination with gamification can be very powerful to increase learning.

By actively listening to students and involving them in decision-making processes, educators can foster a sense of ownership and empowerment among students, ultimately leading to a more inclusive, supportive, and student-centered learning environment. Specifically in this course the lectures could start later, rewards in exam time could be given and rewards in grades can be applied.

Providing direct feedback is a powerful way to enhance student engagement in the learning process. When students receive immediate and specific feedback on their work, they gain valuable insights into their progress and performance, leading to a deeper sense of connection to their learning. Although the intrinsic motivation slightly drops in the second survey, we think that it still is on a higher level than expected.

Gamified workshops offer a dynamic and engaging learning experience that inspires curiosity, fosters collaboration, and empowers participants to apply new knowledge and skills in meaningful ways.

Previous conclusions on their own provide answers for the main question but we would like to address the question how to improve student engagement with challenges in serious gaming also as a whole. Improving student engagement with challenges in serious gaming involves finding a delicate balance between various elements: challenges, gamification, intrinsic and extrinsic motivation, as well as student

autonomy and teacher guidance and support. In the reflection and recommendations we elaborate on this.

References

Aguilar-Cruz P.J. 2022,"Understanding students' engagement with a Serious Game to learn English: A sociocultural perspective"," 23848766,"International Journal of Serious Games

Breiki M.A., Yahaya W.A.J.W. 2021,"Using gamification to promote students' engagement while teaching online during COVID-19",Teaching in the Post COVID-19 Era: World Education Dilemmas, Teaching Innovations and Solutions in the Age of Crisis, Springer

Butler S., Ahmed D.T. 2016,"Gamification to engage and motivate students to achieve computer science learning goals","",,"Proceedings - 2016 International Conference on Computational Science and Computational Intelligence, CSCI Conference 2016.

Deterding, S., Khaled, R., Nacke, L. E., & Dixon, D. (2011). Gamification: Toward a definition. In Proceedings of the ACM CHI Conference on Human Factors in Computing Systems (Vol. 12, pp. 1-4). Vancouver BC, Canada.

Dharmawan B., Rosyad A., Silitonga L.M., Mandamdari A.N., Sunendar, Zulkifli L., Wu T.-T.2022,"BSG - A Serious Game Tool to Improve Student's Self-efficacy, Motivation, and Engagement in entrepreneurship","",03029743,"Lecture Notes in Computer Science

Fullerton, T. (2014). *Game design workshop: a playcentric approach to creating innovative games*. CRC press.

Guay, F., R. J. Vallerand, and C. Blanchard, 2000 On the Assessment of Situational Intrinsic and Extrinsic Motivation: The Situational Motivation Scale (SIMS). Motivation and Emotion 24 3 pp175-213.

Hamari J., Shernoff D.J., Rowe E., Coller B., Asbell-Clarke J., Edwards T. 2016,"Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning",Computers in Human Behavior.

Hart J., Iacovides I., Adams A., Oliveira M., Magroudi M. 2017,"Understanding engagement within the context of a safety critical game","",,"CHI PLAY 2017 - Proceedings of the Annual Symposium on Computer-Human Interaction in Play.

Khaldi A., Bouzidi R., Nader F.2023,"Gamification of e-learning in higher education: a systematic literature review", Smart Learning Environments.

Mohanarajah S., Sritharan T. 2022,"SHOOT2LEARN: FIX-AND-PLAY EDUCATIONAL GAME FOR LEARNING PROGRAMMING ENHANCING STUDENT ENGAGEMENT BY MIXING GAME PLAYING AND GAME PROGRAMMING", Journal of Information Technology Education: Research

Moura A . 2017,"Game-based learning to promote student engagement and motivation to study a novel from classic literature, Mobile Learning: Students' Perspectives, Applications and Challenges. F. M. In René David & Aubin,Corentin (Eds), Mobile Learning: Students' Perspectives, Applications and Challenges. Hauppauge, NY: Nova Science Publishers, Inc., pp.1-31

Newmann, F M, 1992, Student Engagement and Achievement in American Secondary Schools. New York, NY, USA: Teachers College Press, 1992.

Nicholas J., Mills B., Hansen S., Bright S.J., Boyd H., Brook L., Watson J., Hopper L.2022,"Developing an alcohol and other drug serious game for adolescents: considerations for improving student engagement",Australian and New Zealand Journal of Public Health.

O'Brien, H. L., Cairns, P., Hall, M.: A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. Int. J. Hum. Comput. Stud. 112, 28-39 (2018).

Petersen M.S., Jakobsen G.S., Hendriksen D.B., Hansen N.L.S., Bjorner T.",2021,"Can a Serious Game Be Designed to Increase Engagement in a Mandatory Postmodern Novella at Danish Gymnasiums?",Lecture Notes in Computer Science

Psaltis A., Apostolakis K.C., Dimitropoulos K., Daras P. 2018,"Multimodal student engagement recognition in prosocial games",IEEE Transactions on Games.

Rebelo S., Isaias P. 2019,"Gamification As An Engagement Tool In E-Learning Websites", Journal of Information Technology Education: Research.

Ryan,RM & Deci,EL(2000) Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being, January 2000 • American Psychologist , Vol. 55, No. 1, 68-78.

Rowe J., Mott B., Paquette L., Lee S. 2019,"EDM &amp games: Leveling up engaged learning with data-rich analytics","",,"EDM 2019 - Proceedings of the 12th International Conference on Educational Data Mining.

Wolfswinkel, J. F., Furtmueller, E., & Wilderom, C. P. (2013). Using grounded theory as a method for rigorously reviewing literature. *European journal of information systems*, *22*(1), pp45-55.

Yu, M. Gao, and L. Wang, 2020 "The Effect of Educational Games on Learning Outcomes, Student Motivation, Engagement and Satisfaction", Journal of Educational Computing Research.

Zadeja I., Bushati J. 2022,"GAMIFICATION AND SERIOUS GAMES METHODOLOGIES IN EDUCATION", International Symposium on Graphic Engineering and Design.