Proceeding Paper

Augmented Learning: Case Study of Gamified and Extended Reality Courses †

Saverio Iacono

Department of Computer Science and Technology, Bioengineering, Robotics, and Systems Engineering, University of Genova, 16145 Genova, Italy; saverio.iacono@unige.it

† Presented at the 3rd IEEE International Conference on Electronic Communications, Internet of Things and Big Data Conference 2023, Taichung, Taiwan, 14–16 April 2023.

Abstract: The maturation of gamification techniques and virtual reality technologies has progressed differently. Today, gamification has been consolidated, and virtual reality is becoming a widespread technology. These two are united in the university course of "virtual reality, augmented reality and gamification" as the Msc curriculum in Digital Humanities. This is a STEM course where an original gamification system was studied to teach complex topics with different bachelor backgrounds as engineering, design, communication, and literature studies. This research was conducted starting in the academic year 2016–2017 using TV series to create a sense of engagement during the course. The results of the 6 year teaching of the gamified course were presented in this article with constant feedback from involved students.

Keywords: gamification; enhanced learning; extended reality; flipped classroom; e-learning; stem education; computer graphics

1. Introduction

Playing is an activity that is often perceived as a waste of time and an unseemly activity that hinders the maturity of children. With video games, this perception is further spread as numerous teenagers spend many hours playing games such as Fortnite, Minecraft, and Clash of Clans. However, this negative phenomenon cannot ignore the positive aspects of games [1]. Game-based learning is an important step prior to gamification. Pelling used the term for the first time in 2003 [2], and the term was then defined better by Deterding [3]. Unlike game-based learning, in which a game is used to educate content, gamification is applied to non-game contexts with techniques and tools to improve engagement and experience. In 2012, the MOOC on Coursera by Werbach [4] and the books by Kapp, McGonigal, and Chou [5–7] triggered the spread of the term on a larger scale and brought excitement in related research. Gamification is often assimilated into the triad "PBL" (Points, Badges and Leaderboard) as the necessary elements. They also argued that gamification cannot be integrated into every context and always be useful for the purpose, but rather it must be considered a tool to be associated wisely.

The adoption of competitive approaches makes it difficult for those who do not feel activated by the competition and motivated by ranking. Good gamification promotes positive behavior to transform extrinsic motivation into intrinsic motivation [8]. After the wave of aggressive marketing on the subject ended, it became possible to do sensible research without having to chase a trending topic. The narrative approach to gamification can be more engaging but also needs a lot of effort to produce story-driven gamified experiences. Thus, the approach used for this course is based on a story-driven experience with a light approach to PBL. Gamification in STEM higher education is studied to investigate the effectiveness, engagement level, and major tools [9,10].

In this study, a different gamified approach was created and analyzed in the context of a STEM course in Digital Humanities, where the majority of data was collected. Furthermore,

here is presented a preliminary analysis of data collected in the STEM context of an engineering course.

2. Course and Methodology

The course "Virtual Reality, Augmented Reality and Gamification" (hereinafter VRARGAM) is gamified in a deliberately self-referential way, aiming to provide students with the knowledge of the fundamentals of 3D graphics and animation and the practical skills to design applications and systems based on virtual/augmented/extended reality simulation and gamification. Using a methodological approach based on inter/cross-disciplinarity (web programming, computer graphics, biomechanics, sensory perception, robotics, and video games), the expected learning outcomes have always been acquiring design methods and operational tools applicable in creative contexts related to Digital Humanities. In a preliminary article [11], the 2 year experience was described, and the educational experience was built with an innovative method using the theme of a TV series such as Stranger Things (Netflix), Westworld (HBO), Altered Carbon (Netflix), Psycho-Pass (Fuji TV), Upload (Amazon Prime Video), The Good Place (NBC), and Cyberpunk Edgerunner (Netflix). In the principle of inclusive and participatory gamification, the learning of skills and motivation was improved. The gamification slogan was "when students are not just students, but the cast of a TV show." Each participation in a course activity (lectures and seminars) was rewarded based on the schedule of the course and series TV to produce a dynamic cast adaptation every week. This motivated the students to participate in the course. The context of a master's degree program in Digital Humanities provides a strong interdisciplinary component. Students may have different technical-scientific fields but normally have learned Communication Sciences for 3 years. In a nutshell, there might be students with a bachelor's degree in computer engineering with students with degrees in literature and philosophy.

2.1. First Year: Stranger Things and First Rule Setting

The series, in the first year of experimentation, was used to generate interest and a theme important for the course. With its commercial success, the first season of "Stranger Things" was chosen. Taking into consideration the topics of the series compared to those of the course, it was the poorest choice, while the component of creating engagement was much stronger to finalize the general learning. The opening theme of the series was reconstructed starting from the reference font used, namely Benguiat Bold for the title of the series and the macro letters, while Century Gothic Bold was used for the names of the participants. The final rendering of the opening theme was produced with Adobe Premiere and Adobe After Effects. The original musical theme of the series by Kyle Dixon and Michele Stein was also kept. At this stage, we introduced theming, simply trying to stimulate the core drive of the "Epic Meaning" by its framework [7].

The final exam consisted of the creation of a demo of the game and a game design document on the proposed theme with a new story that was parallel or inspired by the original story. At the beginning of each lesson, the opening theme was sent "on air" with personalized credits and titles because each title was inspired by the series and the topics of each lesson. For example, the lesson on 3D modeling was called "The Big Max and the Little Maya," with reference to 3D Studio Max and Maya. The lesson on orientation systems (left hand and right hand) was entitled "The Upside Down." The students were informed that their names included in the opening were not only aesthetic but for changing their position based on their presence during the lessons after the first 2 lessons. In a real show of any genre, the more important actor's name appears before others.

The shifting of names was never really put into practice for a number of reasons. The number of students involved was 33, and the opening theme was simply too short (50 s) and had too little space. Updating the opening with After Effects was difficult to manage because of the inherent complexity of the software. Therefore, scrolling through all the names could not be handled optimally. For the final exam, the students were divided into

small groups of 3 or 4 so that they could work together on a single project and then produce their game design document and a demo/alpha version of their idea using modeling ad game engine skills acquired during the course.

2.2. 5 Years of Experimentation

In the second year, after the good results in the exams were obtained, we chose to reuse the same principle. However, selected something less commercial and closer to the themes of the course and following the new technological trend of A.I.

Thanks to the theme of the "amusement park where anything can happen" safely, like in virtual reality (VR), we proposed the Westworld TV series for the high quality of the narrative production. However, given the complexity of the original opening theme, this has not been entirely recreated, but we eliminated the original credits with After Effects. Students entered their names, and the leaderboard has been updated based on active presence. Students were better organized with a longer theme (1 min 43 s), and fewer students (18) helped the monitoring process. The order of the names was changed at each lesson, and those who did not reach half of the registered attendance were "fired" from the cast and took the exam as "not attending." At the production level, the solution adopted to remove "credits" from the original theme and replace them with course participants has become the standard to be followed for future productions. As a new addition to the course, each student had to produce a pitch document on a personal game proposal and present it: the best idea selected by "the board" (the faculty) became the big project for all students to work on. However, students failed to work together as a large team, challenged by personal, social and productive demands. The competition to impose the best idea produced very interesting document pitches, but in the end, the one selected was really developed only by a small group of 6, thus slightly larger than the previous year, while most of the others ended up creating their own personal project by themselves or in smaller groups. Therefore, they independently recreated the approach given in the previous year.

In the 2018−2019 academic year, the Altered Carbon TV Series was chosen. The number of students had almost doubled (33), and the series provided, in addition to topics close to the course, an opening theme of a similar length to the previous one (1 min and 42 s). The production process was standardized with After Effects. There was the only initial difficulty in recreating the effects of the appearance and disappearance of the names that were harmonious with the original theme. The proposed methodology remains the same, and the projects returned to being performed in small groups of a maximum of 3 or 4 people. The themes of Altered Carbon remained rather connected to the course, thanks to the dynamics of the "change of sleeves," which allowed changing one's body in VR. The theme of possible interaction with A.I. and the normalization of the XR tools was used.

In the 2019−2020 academic year, the chosen series was Psycho-pass, a 2012 anime that maintains a connection with the course topics by showing a possible integration of XR tools into daily life. The course was taught during the COVID-19 pandemic, and as a result, it was converted into an online course. This context, in addition to forcibly changing the starting condition of the experiment, provided an opportunity to understand whether the perception of gamification could change.

The 2020−2021 academic year, characterized by the second and third waves of the COVID-19 pandemic, marked a major increase in the number of students and coincided for the first time with the use of the same series in two different degree programs. The TV series chosen was the first season of Upload. Variations beyond the theme of the series, which offered numerous insights and connections to virtual reality, mainly involved the inclusion of e-learning methodologies: the Online Flipped Classroom [12] and Online Peer Instruction [13]. The new approach required making materials available in advance of class and evaluating their effectiveness in the more technical topics. It also presented an opportunity to test the methodology for a diverse group of students while keeping the main themes of the course unchanged. In addition to the Digital Humanities course (56 students), gamification was provided for the "Virtual Reality for Robotics" course (86 students) for

the Dibris Robotics Engineering course. The teaching, in addition to having students only with an engineering background, was delivered completely in English since the students could be of any nationality. For the 6th year, data is still collected but is currently positively in line, as expected.

3. Data Collection

3.1. Questionnaire and Data

In the first year, we tried to understand if the idea of using a TV series for the course was appreciated by students through interviews after the exams. The opinion of students was positive about having a specific thematic task to do. From this first opinion, we were encouraged to repeat the experience again and refine the previous version of the course with a stronger gamified principle using a hidden ranking. During the 2nd year, discussions emerged among the students about the correct placement of their names in the opening theme. After the second release of the gamified course, a test was conducted based on the Likert Scale to record their liking and perception of the course through six sentences. The survey was to understand if their opinions were in agreement with our statements. The questionnaire contained the following statements: (1) "You have positively perceived the experience of the gamified course," (2) "You would do a gamified course like this again," (3) "You were positively impressed to see your name in the series opening credits," (4) "Having a theme to finalize the course activities has inspired you to try harder," (5) "The presence of your name in the series opening credits has positively influenced your participation in the course," and (6) "You were interested in the series chosen for the course gamification."

The rating scale consisted of five steps ranging from "strongly disagree" to the intermediate step, "neutral," to the last step, "strongly agree." The questionnaire was provided to students via Google Forms in a strictly anonymous form. The questionnaire was distributed to the students after the exam. In the academic years 2019–2020 and 2020–2021, to limit the dispersion, students were asked to fill in the questionnaire immediately after the exam or, at the latest, within 24 h.

After the fourth year, we revised the questionnaire to have a more complete and clear result: (1) "You have positively perceived the experience of the gamified course," (2) "You were positively impressed to see your name in series openings credits," (3) "The movement of your name in opening credits has stimulated you to intervene more frequently during the classes," (4) "You positively perceived that each class began with the opening credits as an introduction to the themes of the day and as a guiding thread of the course," (5) "Having a theme to finalize the course activities inspired you to try harder," (6) "You were interested in the TV series chosen for the gamification of the course," (7) "You would do again a gamified course with the opening credits and names that move, but with different contents and/or objectives."

3.2. Results

The results in 2018 and 2019−2020 are shown in Table 1 (4 years). For (1), an approval rate of 81% of the interview was obtained. For (2), the total satisfaction rate was 46%. A positive feedback of 61% and a neutral feedback of 23% were observed for (3). A positive feedback rate of 75% was obtained for (4). A positive feedback rate of 46% and a neutral feedback rate of 23% were obtained for (5). The overall satisfaction for (6) was 81%, with a neutral feedback rate of 19% and a disagreement rate of 4%.

Table 1. Percentages calculated based on 48 responses.

	😞	🙁	😐	🙂	😀
1	2%	2%	15%	46%	35%
2	6%	29%	19%	27%	19%
3	3%	13%	23%	27%	34%
4	0%	10%	15%	46%	29%
5	6%	12%	23%	19%	27%
6	2%	2%	19%	6%	75%

There was a high level of satisfaction with the course gamified experience (1), but students did not want to repeat an experience of this type (2). It was, therefore, decided to change the positioning of the sentence by clearly clarifying that it was a different course from VRARGAM. The teaching group of the course was aware of the complexity and commitment that required the exam related to VRARGAM. It was necessary to understand if this type of gamification could be favored. Two questions were added: "Has it happened that your name has receded in the opening credits?" and "if so, was it a stressful experience for you?".

In Table 2, the results for the academic year 2020/2021 based on the new questionnaire for VRARGAM were presented. For the last two Yes/No questions, 56% of those interviewed answered yes, and 88% said they did not find it stressful to see their names removed from the opening credits for the first question, "Did it happen that your name lost its position in opening credits?" and "If Yes, was it a stressful experience for you?". As expected, for (7), a high agreement rate of 72% was observed.

Table 2. Percentages calculated based on 38 responses.

	😞	🙁	😐	🙂	😀
1	0%	0%	6%	44%	50%
2	0%	0%	6%	44%	50%
3	10%	9%	31%	22%	28%
4	0	10%	6%	34%	50%
5	3%	3%	12%	38%	44%
6	3%	10%	6%	6%	75%
7	0%	9%	19%	34%	38%

Results of VR for Robotics Course

The last part of this research was for a group of students extremely different from the original sample. As anticipated, the gamified experience was also provided to students of the "VR for Robotics" teaching (the first semester of the academic year 2021/2022) of the master's degree in Robotics Engineering. In this way, it was possible to further investigate on a sample of international students whether the gamification model implemented could have the same impact in this case. The course, in addition to being dedicated to students with a background in engineering studies, was held in English and open to students with heterogeneous cultural origins compared to that experienced previously. We had no idea how this type of gamification would be welcomed or experienced. There were 82 students enrolled in the course, of which 25 took the exam on the final date of February 2022, and an average of 20 students followed the lessons on Microsoft Teams, thus participating in gamification. The data collected are, therefore, few but interesting (Table 3).

Table 3. Percentages calculated based on 21 responses.

	😦	🙁	😐	🙂	😄
1	5%	14%	0%	57%	24%
2	14%	5%	29%	33%	19%
3	19%	14%	34%	14%	19%
4	19%	19%	9%	24%	29%
5	19%	9%	10%	38%	24%
6	19%	14%	19%	14%	34%
7	5%	19%	14%	33%	29%

The overall positive perception remained high, with 81% for (1). In the VR for Robotics sample, with the revised version of the questionnaire, the results appeared more distributed. Despite the 18.3% increase in negative opinions, the positive responses remained at a higher percentage. The only exception was for (3). Compared to Digital Humanities students (27.7% of disagreements in the VR for Robotics and 9.4% in the VRARGAM), students showed overall positive opinions.

4. Conclusions and Future Works

The result highlighted that the goal of creating gamification based on participation was achieved. Despite the ranking system, it generated engagement and improvement in involvement in class (46% and 48% of the Digital Humanities). There was a need to induce competition stress (88% did not feel stressed by falling back in the rankings), but students had the pleasure of participating in the gamified experience (81% and 94% for the first and second questionnaires). The 6th year data are still collected (connected to The Good Place TV series), but the trend is still positive. Therefore, we are going to proceed for the next year in Digital Humanities with the already announced theme "Cyberpunk Edgerunner," which allows us to mix Sci-Fi literature and video games. The next step is to find external partners to test this experiment and consolidate the approach. Furthermore, it is necessary to measure the high engagement that seems to be confirmed and the learning potential.

References

1. Huizinga, J. *Homo Ludens*; Taylor & Francis: London, UK, 1998; ISBN 978-0-415-17594-4.
2. Pelling, N. The (Short) Prehistory of "Gamification" . . . Funding Startups (& Other Impossibilities). 2011. Available online: https://nanodome.wordpress.com/2011/08/09/the-short-prehistory-of-gamification/ (accessed on 20 February 2023).
3. Deterding, S.; Dixon, D.; Khaled, R.; Nacke, L. From Game Design Elements to Gamefulness: Defining "Gamification". In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, New York, NY, USA, 28 September 2011; pp. 9–15.
4. Werbach, K.; Hunter, D. *For the Win, Revised and Updated Edition: The Power of Gamification and Game Thinking in Business, Education, Government, and Social Impact*; Wharton School Press: Philadelphia, PA, USA, 2020; ISBN 978-1-61363-105-8.
5. Kapp, K.M. *The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education*; John Wiley & Sons: Hoboken, NJ, USA, 2012; ISBN 978-1-118-09634-5.

6. McGonigal, J. *Reality Is Broken: Why Games Make Us Better and How They Can Change the World*; Vintage: New York, NY, USA, 2012; ISBN 978-0-09-954028-1.

7. Chou, Y. *Actionable Gamification: Beyond Points, Badges, and Leaderboards*; Packt Publishing Ltd.: Birmingham, UK, 2019; ISBN 978-1-83921-077-8.

8. Deci, E.L.; Ryan, R.M. The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychol. Inq.* **2000**, *11*, 227–268. [CrossRef]

9. Venter, M. Gamification in STEM Programming Courses: State of the Art. In Proceedings of the 2020 IEEE Global Engineering Education Conference (EDUCON), Porto, Portugal, 27–30 April 2020; pp. 859–866.

10. Pérez-Jorge, D.; Martínez-Murciano, M.C. Gamification with Scratch or App Inventor in Higher Education: A Systematic Review. *Future Internet* **2022**, *14*, 374. [CrossRef]

11. Iacono, S.; Vercelli, G.V.; Bellanti, E.; Corsi, A. A lesson learned about gamification and engagement in a master degree course. In Proceedings of the 11th annual International Conference of Education, Research and Innovation, Seville, Spain, 12–14 November 2018; IATED: Seville, Spain, 2018; pp. 2898–2902.

12. Che, Y.; Pan, Q.; Yang, J.; Ding, D.; Wan, J. Design and Practice of the Online Flipped Classroom under the Guidance of Learning Drive Based on a Network Teaching Platform. In Proceedings of the 2021 2nd International Conference on Information Science and Education (ICISE-IE), Chongqing, China, 26–28 November 2021; pp. 1273–1276.

13. Vallarino, M.; Iacono, S.; Zolezzi, D.; Vercelli, G.V. Online Peer Instruction on Moodle to Foster Students' Engagement at the Time of COVID-19 Pandemic. *IEEE Trans. Educ.* **2022**, *65*, 628–637. [CrossRef]