

SIRIUS GAME AND PLAYFUL LEARNING: THE OPPORTUNITY TO MAKE MISTAKES

SIRIUS GAME E PLAYFUL LEARNING: L'OPPORTUNITA' DI POTER SBAGLIARE



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ABSTRACT

Serious games are designed to educate, train, or raise awareness on specific topics while also entertaining. Unlike traditional video games, which are primarily for fun, serious games focus on educational or training goals. In this experiment, Sirius Game will be used to explore how integrating immersive technologies, like serious games, influences cognitive, metacognitive, motivational, and emotional aspects of learning, particularly in Latin and other subjects. The first experiment, conducted with Sirius Game's founders and Harvard, was analyzed to inform a new research project, making it more inclusive. Results from the initial experiment showed that serious games create a more engaging and motivating learning environment, demonstrating significant potential for wider use in education. Future research will gather more data on how this gamified approach can enhance teaching practices and learning outcomes. This article will introduce new research questions that build on the initial study, incorporating elements of inclusivity and educational improvement related to the subjects explored. These updates aim to refine the understanding of how serious games can transform educational experiences.

I serious games sono progettati per educare, formare o sensibilizzare su argomenti specifici, ma anche per divertire. A differenza dei videogiochi tradizionali, che hanno come scopo principale il divertimento, i serious games si concentrano su obiettivi educativi o formativi. In questa sperimentazione, Sirius Game verrà utilizzato per esplorare come l'integrazione di tecnologie immersive, come i serious games, influenzi gli aspetti cognitivi, metacognitivi, motivazionali ed emotivi dell'apprendimento, in particolare in latino e altre materie. Il primo esperimento, condotto dai fondatori di Sirius Game e Harvard, è stato analizzato per programmare una nuova ricerca con l'intento di sperimentare l'inclusività. I risultati dell'esperimento iniziale hanno dimostrato che i giochi seri creano un ambiente di apprendimento più coinvolgente e motivante, dimostrando un potenziale significativo per un uso più ampio nell'istruzione. La ricerca futura raccoglierà ulteriori dati su come questo approccio gamification possa migliorare le pratiche di insegnamento e i risultati dell'apprendimento. Questo articolo introdurrà nuove domande di ricerca che si basano sullo studio iniziale, incorporando elementi di inclusività e di miglioramento educativo relativi ai temi esplorati. Questi aggiornamenti mirano a perfezionare la comprensione di come i giochi seri possano trasformare le esperienze educative.

KEYWORDS

Serious game; education; motivation; Sirius Game; gamification
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Introduction

The popularity of serious games in education has grown worldwide, with an estimated market worth \$5.94 billion in 2020 and a growth rate, over the last 2 years, of nearly 100% per year (Gaikwad, 2022). It is estimated that the serious games market will keep growing quickly to reach a value of \$32.72 billion by 2030 (Gaikwad, 2022).

The role of teachers finds itself in a moment of profound re-examination. The traditional model of teaching is placed under the lens of innovation, considering the impact that digital technologies and contemporary media bring in everyday life. Unexpected challenges and still underexplored possibilities are included in the current reflections of educational psychologists, pedagogists, and philosophers of education, attempting to capture tools, models, and practices that can “tune” teaching action to the communicative and informational dynamics of the 21st century, with a specific focus on digital media (Limone, 2021; Rahmatullah et al., 2022).

Taking care of teachers’ competencies is essential to determine a satisfactory level of quality in teaching, with a crucial impact on the proper functioning of educational services. Among the tasks of universities, teacher training is undoubtedly one of the most important: according to Sun et al. (2020) should be based on improving teachers' skills, bringing benefits to students' overall preparation. However, to be truly effective, this training must consider the latest developments in technology-supported learning which is constantly evolving.

The engine, which drives, the constant quest to improve teacher performance is the need to keep up with Generation Z, commonly referred to as, digital natives.

The challenge lies in making subjects, even static subjects far removed from our times, such as Latin, Greek and philosophy, and making them more accessible. One needs to create intrinsic connections between the learning content and game mechanics to facilitate deeper procedural and conceptual understanding (Denham, 2013).

The connecting link is dictated by motivation-the more kids are fascinated by play, the more they learn and keep up with teaching.

Some authors (e.g., Eastwood et al., 2007, 2012; Weinerman & Kenner, 2016) point to developing boredom awareness as one of the crucial responsibilities of a present-day teacher who, given that this negative emotion is common to most students in virtually all learning environments (Goetz et al., 2014; Pekrun et al., 2010), should even arrange a class in which boredom would be openly discussed rather than treating this unfavorable condition as a taboo topic.

The birth date in teaching technologies is made to coincide with the publication of the article "The Science of Learning and the Art of Teaching": published in 1954, in this article Skinner describes in detail his behaviorist theory of learning, characterized by the importance of positive reinforcement in facilitating learning. However, the teacher sometimes does not prove to be an effective tool in providing immediate feedback, and cannot guarantee prompt, frequent, and rapid reinforcement that can lead to effective acquisition of concepts (Skinner, 1954).

Skinner proposes as a solution to entrust this role to machines guided by the sequence of programmed actions. Lessons are divided into units (frames) at the end of each of which questions are asked to check whether the learner has learned the concepts of the concluded frame (Pulcini, 2004). If so, the learner can move on to the next frame, otherwise he or she must repeat the module that he or she failed to answer.

In this way, not only is the learner followed individually by the machine, but the teacher is also freed from the task of having to mark the right and wrong answers (Skinner, 1954).

1. Analysis of needs

In the European Higher Education Area, the term competence has moved to the forefront of current pedagogical discourse. In this environment, through the Tuning Project (Gonzalez & Wagenaar, 2003), it has been further refined to refer to the "dynamic combination of attributes - with respect to knowledge and its application, to attitudes and responsibilities- that describe the learning outcomes of an educational program, or how learners are able to perform at the end of an educational process" (p. 280).

In 2010, serious games evolved to the point of incorporating real-world economies, such as Second Life, a virtual world where users can create real activities that provide virtual goods and services, all for Linden Dollars, which can be exchanged for U.S. dollars.

With the advent of increasingly advanced and immersive technologies, serious games have also expanded into more areas where they can be helpful. An example of this is the serious games released by the Italian National Institute of Health in 2021: within the CCM Project "Psychoeducational program for emotional self-regulation aimed at young people to promote mindful use and prevent problematic use of the Internet," serious games were developed to test young people in critical situations, allowing them to learn cross-cutting skills such as emotion regulation

and problem-solving. The field of serious games is continuously growing, as they are becoming more useful to modern society, thanks to the ongoing improvement of technology that has enabled the expansion of their areas of application.

2. Serious game

Recent studies show that Serious Games have been used for different purposes in schools all over the world: to raise learning motivation and also to foster students' language and mathematical skills, to help students learn about history, ethics or science (Wastiau, Kearney, & Van den Berghe, 2009; Vu & Feinstein, 2007), to reduce school phobia (Wastiau et al., 2009), or to sensitize students to dangers on the Internet (Iten & Petko, 2016).

The potential of Serious Games is also constantly exploited in professional training (Pourabdollahian, Taisch, & Kerga, 2012; Cain & Piascik, 2015; Le Compte, Elizondo, & Watson, 2015; Wilson, Calongne, & Henderson, 2015), especially in commercially oriented companies (Dicheva, Dichev, Agre, & Angelova, 2015). Research also shows that certain Serious Games are used for both addiction and disease prevention (Willmott, Taylor, Russell-Bennett, & Drennan, 2019; Winksell, Sabben, Akelo, Ondeng'e, Odero, & Mudhune, 2019).

Also according to Willmott et al, digital games are possible vehicles for learning processes of a different nature. Providing schools with information and communication technologies (ICT) in the form of computers, software, internet access and digital content, and providing teacher training programmes for these technologies, have not proved sufficient for the teaching process to be transformed. Personalisation of teaching and learning, transdisciplinary approaches, meta-cognitive development and learner empowerment, have not been systematically implemented by bringing ICT into the classroom. Digital games have the potential to contribute to this renewal, through the resources and know-how invested in their design to challenge players and keep them interested.

Serious Games are, moreover, usually played on a computer and create an entertaining mental contest. Despite providing entertainment, the primary purpose of Serious Games is learning rather than entertaining (Zyda, 2005; Klopfer, Osterweil, & Salen, 2009; Gotterbarn, 2013). Serious Games are driven by educational goals of fostering learning in a variety of domains (Zyda, 2005).

Serious games aim to convey learning content in a playful manner. They create playful challenges that lead to an increase in learning motivation (Breitlauch, 2012), a key factor in current pedagogical research. To increase learning motivation, the

following requirements must be fulfilled: firstly, play must be fun. Therefore, an appealing game mode that is suitable for the target group is required.

Secondly, the game must be adapted to both the explicit needs and abilities of the target group. Thirdly, students need to be aware that they are not only playing for fun, but also for learning (Martens, Diener, & Malo, 2008; Derbali & Frasson, 2012; Breitlauch, 2012; Erhel & Jamet, 2013; Chen & Law, 2016; Iten & Petko, 2016; Yang, Chun, & Chiag, 2018).

Many researchers hypothesize that the increased motivation triggered by learning with Serious Games supports students in acquiring school or academic skills and competences (Boyle et al., 2011; Chu & Chang, 2013; Cheng, Lin, She, & Kuo, 2017; Vu & Feinstein, 2017; Yang et al., 2018).

However, the findings on whether increased motivation leads to better learning re-attainment are inconclusive. A meta-analysis on the effects of computer games and interactive simulations in schools confirms that increased motivation can improve learning outcomes (Vogel, Vogel, Can-non-Bowers, Bowers, Muse, & Wright, 2006).

3. Research hypothesis

This research aims to explore the strengths and weaknesses of the gamified e-learning platform, SiriusGame, designed for the teaching and learning of Latin and beyond, in Italian high schools. This serious game was created by Laura Cesareo and Miriam Torregrossa to be used as part of an innovative teaching methodology, combining project-based learning, collaborative learning, flipped classrooms, and immersive learning.

Our research hypothesis includes the following points:

- What cognitive, metacognitive, motivational, and emotional effects do students experience when transitioning from a traditional lecture supported by technological aids to an immersive teaching approach?
- What is the relationship between teachers and educational technologies?
- Has there been an improvement in student performance in subjects due to the use of serious games?
- How inclusive has Sirius been for students with DSA/BES certification?

The research will involve administering several pre- and post-intervention tests, including the QSA test and the Interpersonal Technology Integration Scale.

The QSA (Questionnaire on Study Attitudes) is an evaluation tool used to analyze students' attitudes and perceptions regarding their approach to studying and

learning. The test explores various aspects, such as motivation, organization, time management, and study habits. The results obtained from the QSA provide useful information to better understand students' difficulties and preferences, aiming to improve teaching strategies and enhance the overall learning experience.

The Intrapersonal Technology Integration Scale (ITIS) was developed by Niederhauser and Perkmen (2008) to study the role played by teachers' beliefs in the process of integrating technology into the classroom. The conceptual framework is based on the Social Cognitive Career Theory (SCCT) (Lent, Brown, and Hackett, 1994), with key mechanisms focusing on the concepts of Self-Efficacy (SE), Outcome Expectation (OE), and Interest (INT).

The ITIS scale, in its original version, is a self-assessment questionnaire consisting of 25 items aimed at evaluating SCCT factors along 4 subscales: Self-Efficacy (6 items), Outcome Expectation (9 items), Interest (6 items), and Behavioral Intentions (4 items).

The usage and performance of Sirius by students will be monitored throughout the process.

4. SiriusGame: First Research Study

Two assessment tools were used – a pre-program survey and a post-program survey – to conduct a formative evaluation of the SiriusGame platform. Both tools were administered to the same group of eighth-grade students, aged twelve to thirteen, and to two professional educators from the bilingual school Bambi e Bimbi in Verona. The students completed a pre-program survey, followed by the use of the SiriusGame platform for two hours a day during school lessons over a four-week period, and finally, a post-program survey.

Additionally, a larger population of SiriusGame users, consisting of those who had signed up for the beta version waiting list, was also considered.

The evaluation team deemed these two populations to be the most appropriate for providing reliable indicators of user preferences (students) and those likely responsible for purchasing the platform (parents and teachers). The first tool aimed to gather information on the general state of potential users before they used the platform. Since SiriusGame's purpose is to increase motivation and interest in learning Latin in Italian schools, it was crucial to understand the beliefs and emotions of students, teachers, and parents regarding the experience of learning Latin in the classroom.

These opinions could have stemmed from their personal experiences or memories from family and friends, meaning any factor that might influence the needs, beliefs, and feelings of the respondents. Additionally, the intent was to establish a baseline for the respondents' experience with educational technologies, including their inclination to use such tools. The tool primarily contained quantitative questions, such as ratings, scales, and binary selections; however, there were also regular opportunities for qualitative responses via free-text input.

The tool was designed to be used by two distinct groups: the group of students directly participating in the supervised classroom program ($n=10$) and a larger population of respondents ($n=30$) who had signed up for the waiting list to receive beta versions of the platform and general updates. Both versions of the tool were distributed through Harvard Qualtrics. The student group completed the survey in a single session on March 11, 2021, while the waiting list group had the opportunity to complete it online between March 12 and 30, 2021. Considering the possible age variety (since the characteristics of the waiting list population were unknown at the time of the tool's development), the evaluators decided to write the survey questions at a sixth-grade reading level.

Furthermore, various response formats were used to maintain interest, including free-text input, allowing respondents to provide additional opinions if desired.

Finally, the time required to complete the survey was limited to under 15 minutes to encourage participation, particularly from the waiting list population, as there was no external motivation to complete it. Moreover, the waiting list population received a slightly customized survey, with additional questions about their likelihood of supporting the platform, as it was believed that this group would be more inclined to determine students' access to the platform.

The stakeholders approved the survey before distribution, and before data collection, they anecdotally predicted that most respondents would likely have a neutral to negative emotional evaluation of Latin teaching in the Italian school system, based on the nature of traditional pedagogical approaches in Italy and testimonies from family and friends who had studied Latin during their school careers.

The stakeholders also hypothesized that many respondents would likely be receptive to the use of educational technology to support learning goals. The SiriusGame platform is based on the idea that these preconceived notions underlie the unsatisfactory Latin learning experiences and that this technology can help change that perspective.

The SiriusGame post-program survey was designed to serve as an overall evaluation of the program and to supplement the initial pre-program evaluation.

The questions were intended to explore how the attitudes, feelings, and beliefs of Italian students regarding Latin in high school had changed after using SiriusGame, evaluating the platform's features holistically, and analyzing users' future intentions regarding its use. Participants were also given the opportunity to freely express their opinions on any aspect of the program not addressed in the questions.

The eleven users of the third-grade platform were given all the time necessary to complete the post-program Qualtrics survey using the laptops provided by the school. At least thirty minutes were dedicated to this task on the final day of the program. To encourage greater engagement, the questions required numerical answers in fill-in-the-blank spaces, brief written responses, multiple-choice selections, and answers with checkboxes and sliding bars.

Although the survey was written in English to ensure project consistency, the SiriusGame team, led by Laura Cesaro, translated each question into the students' native language. One limitation of this approach is that linguistic nuances, including verb conjugations and numerical values, may have been lost in translation. It is unclear to what extent this may have influenced the final responses.

Before analyzing the data, stakeholders had hypothesized that students would likely have a negative or neutral attitude towards Latin due to the often routine and stressful way the subject is taught in Italian schools (Cesaro, 2020). SiriusGame was designed to offer an engaging teaching method for Latin, using motivating elements like avatar creation, progress tracking, and collaborative forums. While stakeholders believed that students would appreciate these features, they were uncertain about which areas of the platform would develop, preferring to let the survey data reveal these trends.

The creators of SiriusGame focused their observation on a formative evaluation of socio-emotional learning related to the ancient world, rather than focusing exclusively on the Latin language.

The research questions, administered via a sheet where teachers recorded the data, were as follows:

- To what extent does interaction with SiriusGame affect the attitudes, emotions, and beliefs of Italian students regarding high school Latin?
- Which features of SiriusGame are most effective in engaging users and why? Conversely, which are less effective?

Observation Plan

Date	Topic	Facilitator	Location	Observer
11 th March 2021	Introduction to SiriusGame	Laura Cesaro	Face-to-face	Laura Cesaro
18 th March 2021	Use Scratch to create a project inspired by SiriusGame	Two teachers	Online (due to covid restrictions)	Laura Cesaro

Four sessions were planned, with the first one introduced by Laura Cesaro. The following three sessions were conducted by two educators who had taught this class in the final year: one focused on programming, while the other teaches Italian literature and grammar, using etymology to explore the Latin language. No personally identifiable information was recorded with this tool. The table below describes the types of information that will be recorded in each column:

Column	Contents	Connection to research questions
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Time	Pre-filled column with timestamps for every 5 minutes that we are observing the classroom.	Defines our sampling strategy ,and helps us understand the time sequence of the event recorded.
Student action	Describes actions that students take at a specific time (e.g. "express excitement" "asked one of their peers' for help").	Illustrates students' attitudes, feelings, and beliefs towards learning of Latin while engaging with SiriusGame

The results revealed that students spent most of their time creating avatars, an activity that generated very positive feelings. The virtual reality feature and the exercises were appreciated, but to a lesser extent.

Finally, student engagement was assessed. The data shows that all students were engaged when using the proposed technologies. They also used MakeyMakey to animate a video game in Scratch, developed with characters and stories from SiriusGame.

This activity took place during the last session, in a group setting. However, inclusion and engagement were lower when students used Scratch alone during online lessons, with reduced support from the educators.

4.1. Results of the First Research

The data from both populations showed that students generally expected to engage in some form of Latin teaching at school, primarily due to the expectations of parents or the school curriculum. Additionally, they believed that the learning experience, in its current form, would be mostly neutral or positive. However, there were concerns regarding difficulty, motivation, and commitment, which could negatively impact the experience. Most stakeholders had likely already had experience with educational technologies and were willing to support a new technological platform to enhance this type of experience.

In summary, the data highlights a desire for a positive change in students' Latin learning experiences within the sample populations, along with the belief that educational technology could offer a more positive experience. This is an encouraging initial sign for the SiriusGame platform and suggests a potential market interest for the product.

All the data come from a pilot program conducted in a middle school class at the end of a four-week program. Due to the Coronavirus pandemic that affected Italy, the pilot program was adapted to a remote mode starting from the second week during the country's lockdown period. Although the students completed the pilot program digitally, the results may have been influenced by the pandemic. Both the alteration of instruction and the general fatigue caused by the pandemic impacted the results.

Overall, survey participants rated their experience with SiriusGame positively, with an average score of 2.55 out of 5, and reported that their feelings towards Latin remained neutral or improved. These results indicate a positive response from users, despite the challenging global circumstances.

When analyzing the overall emotions of the class throughout the four sessions, the following results were obtained:

First session: 50% positive - 50% negative

Second session: 30% positive - 70% negative

Third session: 30% positive - 70% negative

Fourth session: 90% positive - 10% negative

Students mainly appreciated the features of SiriusGame that offered some personal choice and collaboration opportunities. Among the most appreciated aspects were avatar creation, Makey-Makey, and the Not-so-Sirius forum, all favored by the majority of respondents.

To address the second research question, the various features of SiriusGame were coded and translated into an overall percentage, resulting in the following:

Avatar creation: 50%

Virtual reality: 30%

Not-so-Sirius: 10%

Exercise: 10%

On the other hand, the less appreciated functions were those that did not involve interaction and were more focused on language learning, such as translation activities, Roman history, and grammar videos.

Since SiriusGame aims to increase motivation and interest in learning Latin in Italian schools, it was important to establish students', teachers', and parents' beliefs and emotional significance regarding the current experience of Latin lessons. These opinions could stem from personal experiences or memories of family members or friends—any source that could influence the respondent's needs, beliefs, and feelings. Additionally, the goal was to establish a baseline for the respondent's experience with educational technology, including any inclinations toward its use.

The tool primarily contained quantitative questions, using ratings, scales, and binary selections; however, there were regular opportunities for qualitative responses through open-text input.

5. Discussion and conclusions

The analysis of the collected data highlights several significant aspects:

SiriusGame had a positive impact on students' attitudes toward learning Latin.

The most appreciated feature was avatar creation, while the least liked was the translation service.

During online lessons, where students worked independently, there was a drop in engagement and motivation, with more limited participation.

Activities that involved a collaborative approach between students and the integration of various technologies were the most engaging, especially in the final session.

The study revealed several limitations that could be explored in future evaluations. The Bambi and Bimbi school is bilingual, but the students' mother tongue is Italian, while most of the formative evaluation team's mother tongue is English, with little to no proficiency in Italian. Despite close collaboration with stakeholders, some linguistic nuances might have influenced the true intent of the survey questions.

This effect may be more pronounced in the data from the waiting list population, collected via the first tool, as respondents were not required to have linguistic skills other than Italian. Additionally, the impact of COVID-19 cannot be overlooked when analyzing the data regarding attitudes towards learning, emotional significance, and the enjoyment experience of the respondents.

The responses might have been influenced by the emotional context of a globally disruptive year, which had effects independent of the experience with SiriusGame. This could have had a particular impact on students' experiences during the shift from in-person to virtual lessons. Furthermore, some student responses might reflect the perception that Latin is not an immediately relevant subject for second-year middle school students, as they are not required to study it beyond one year.

This idea is supported by some survey responses indicating that SiriusGame would be more suitable for "students studying Latin" or "high school students." Therefore, some of the collected data, such as opinions on Latin and the comparison between language learning methods, might suggest a lack of current need for this program in this specific cohort, rather than a judgment on its effectiveness for the intended target. This could also explain why the likelihood of this cohort using the program increases with time and age.

Finally, the student population at the Bambi and Bimbi school was relatively homogeneous, both culturally and socioeconomically. Future studies could benefit from including more diverse populations in both categories.

Despite these limitations, the evaluation team believes the collected data is sufficiently in-depth to support decision-making in the later stages of platform development. The comparison between these data and those collected through other analysis tools revealed overall consistency, particularly regarding improvements in attitudes toward Latin, the preference for avatar creation, and the effectiveness of cooperative activities.

Each observation is inevitably influenced by the personal background of the researcher, making absolute impartiality difficult. In this case, the presence of the observer in the classroom may have conditioned the students' behavior, as they may have altered their attitude due to being observed or the role of the researcher in the educational context.

However, collaboration with a research team helped reduce the risk of bias. The analysis of data from other tools, where the researcher was not directly involved, provided a broader perspective and helped validate the results in a more objective and reliable manner.

This new research project, which will involve Sirius Game and our university, aims to test with high school students how a serious game can modify the learning of Latin and other subjects. The data, in anonymous form, will provide us with a comparison of before and after usage. Additionally, it will assess how well teachers are able to leverage these technologies and how motivational this approach is.

We will try to gather more data regarding the use of Sirius and how this gamified approach can facilitate teaching.

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