Game-Based Learning for Information Systems Agile Development

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Objectives. Agile methodologies are crucial in software engineering and information systems (IS) development. However, traditional training methods can struggle to convey abstract theoretical concepts effectively and may lead to reduced engagement. We propose that combining several learning methodologies and incorporating serious games and gamification strategies in training can offer a more innovative and engaging approach to improve comprehension. This article outlines a game-based learning strategy designed to instruct information systems students in agile development. Our approach is rooted in active learning principles, incorporating methodologies such as problem/project-based learning, microlearning, collaborative learning, and learning by doing. The course design unfolds in two phases. Initially, participants delve into short, serious games that vividly demonstrate theoretical concepts, followed by brief moments of theoretical exposition. In the subsequent phase, participants apply all the knowledge they have acquired through an extensive project. To illustrate and evaluate the overall process, this approach was implemented to teach Scrum in several training courses. *Participants.* The participants in this study were information technology and systems students at different academic levels. *Study Method.* The research model adopted in this work is based on the Design Science Research (DSR) method. Adhering to the DSR method, the study advanced through distinct phases: recognizing the challenge of engaging Agile Development education, formulating a solution with a course design that blends game-based learning and diverse learning methodologies, developing the course artifact, practically implementing it with Scrum with several groups in different contexts, and assessing its effectiveness using pre- and post-course quizzes. The course aimed to instruct participants in agile methods within information system development. *Findings.* Feedback from the courses was clearly positive, with participants expressing a preference for the proposed game-based approach over traditional expository lecture methods. Pre- and post-course knowledge quizzes revealed a noteworthy increase in correct answers and overall scores in the end. *Conclusions.* The novelty lies in an integrated approach that combines multiple active learning methodologies—such as game-based learning, microlearning, collaborative learning, project-based learning, and learning by doing—to facilitate the comprehension of theoretical concepts through practical application.

CCS Concepts: • **Information systems**; • **Applied computing** → **Education**;

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1 Introduction

Agile methodologies play a pivotal role in the domain of software engineering and, in the last few years, have gained prominence in the realm of information systems development. As Baham [2019] asserted, **Agile System Development (ASD)** methodologies have not onlyfound a place but also have become a mainstay in the contemporary business world. This recognition emphasizes the need for a comprehensive understanding and integration of ASD practices into the fabric of information systems education. However, expository-based traditional training can make abstract concepts difficult to grasp. Gamification and serious games present a potential solution.

Considering the ever-growing importance of agile methods, it is imperative to integrate them into information systems courses. Babik [2022] observes that academic programs across various disciplines, including information systems, computer science, and business, have recognized the industry's call for graduates well-versed in Agile practices, such as Scrum. To meet this demand, educational institutions have proactively responded by incorporating Agile-related pedagogy into their curricula. This adaptation ensures that students are equipped with the knowledge and skills essential for thriving in workplaces where agile methodologies have become integral to effective project management and information systems development.

However, traditional training methods (primarily reliant on expository approaches) present challenges in grasping theoretical concepts, especially those characterized by a high level of abstraction. Additionally, such methods tend to undermine class engagement, diminishing the allure of participation and often resulting in periods of reduced and scattered attention among students. As highlighted by Rush and Connolly [2020], many students are frequently exposed to introductory activities or lessons that cover the "what" of agile without delving into the crucial aspects of "how" and "when" to apply these principles. May et al. [2016] further argue that a significant portion of systems analysis and design textbooks only briefly touch upon Agile methodologies, specifically Scrum.

Scrum is an iterative, incremental, and empirical framework for managing and controlling project development [López et al., 2016]. According to Ma'arif et al. [2018], it is distinguished by its flexible organizational structure, timely and interactive feedback, and dynamic involvement of team members. Hron and Obwegeser [2018] summarize Scrum's process, which involves dividing development into Sprints (time-boxed iterations), each ending with delivering a usable product. Before starting a new Sprint, there's a planning meeting where developers and stakeholders choose tasks. After every Sprint, retrospectives take place to facilitate reflection on the employed work practices.

In this article, we present an approach and course design centered around games and serious games that combines microlearning, collaborative learning, project-based learning, and learning by doing, intending to be a model for replication by other educators. Incorporating serious games intercalated by brief moments of theoretical explanation and implementing gamification strategies within training endeavors represents an innovative approach poised to streamline the comprehension of fundamental concepts. This shift toward a more engaging and student-centric model is well aligned with the requirements of learning methods for 21st-century [Kearney et al., 2024] and holds the potential to reshape the dynamics of teaching and learning, fostering a more effective educational environment.

To illustrate and evaluate the overall process, we designed an agile course with Scrum as the main framework. The innovation lies in integrating practical application with theoretical learning: initially, key Scrum concepts are explored through brief serious games (10–20 minutes), providing tangible illustrations, followed by concise expository sessions to solidify the understanding gained from each game. Subsequently, in a second phase, students, armed with these acquired concepts, engage in a more extensive project (4 hours) involving all the enrolled students working in teams, thereby applying and reinforcing their comprehension in a real-world context simulation. These games served as experiential tools, enabling participants to engage practically with the theoretical concepts discussed. This represents a pioneering application and study of such an approach within learning agile methods.

The article is structured as follows. Section 2 comprehensively explores key theoretical concepts, specifically "game-based learning" and "active learning methodologies," along with an examination of related work and its contributions. Section 3 provides an in-depth look at the research methodology guiding this work. The subsequent section discusses the results of the training evaluation (Section 4), and Section 5 critically analyzes the main findings. Lastly, Section 6 encapsulates key insights and outlines prospects for future work. Appendix A describes the course design, applied games, and the organization and execution of the training. Appendix B provides the evaluation questionnaire.

2 Background

2.1 Active Learning Approaches

2.1.1 Game-Based Learning. Game-based learning and gamification, widely used in workplace training, education, and social media, are techniques many people have experienced, knowingly or not [Pho and Dinscore, 2015]. The literature has several related concepts, such as game-based learning, gamification, serious games, and game-based pedagogy. According to Al-Azawi et al. [2016], gamification is the application of game design elements, mechanics, and thinking in non-game activities to inspire and engage participants. This involves employing game elements like points/scores, reward systems, or badges. Serious games are characterized by an explicit and carefully planned educational purpose, diverging from the primary aim of amusement, and have been extensively employed in training and military settings [Laamarti et al., 2014]. In contrast to gamification, where game elements are added to non-game tasks, serious games are purpose-built games that employ game mechanics within a complete game environment to support learning. They are increasingly used as complements to traditional teaching materials because they promote active, experiential, situated, and problem-based learning and provide immediate feedback, all of which are regarded as key features of effective learning [Kharbouch et al., 2025].

Becker [2021] clearly distinguishes between game-based pedagogy and game-based learning, emphasizing their interconnected nature as complementary. According to Becker, game-based pedagogy involves the teaching process through games from the teacher's standpoint, while game-based learning focuses on the learning process through games. The game-based learning approach prioritizes students and improves teaching effectiveness [Karakoç et al., 2022]. Gee [2009] uses video games to explain key learning principles that support effective game-based teaching methods. The author highlights that players co-design games through actions, fostering control, ownership, and a sense of agency [Deed, 2015]. Another key learning principle Gee [2009] noted, revolves around encouraging risk-taking, motivated players to explore and experiment with new strategies. This is only made possible by a strategic design of initial problems, which prepares players for more intricate challenges, allowing them to engage and perform even before achieving full proficiency.

Game-based learning is situated within the framework of the active learning methodology, sharing the goal, alongside other active learning practices and strategies, of actively involving students in both the teaching and learning processes [Moya, 2017]. Two active learning methodologies that hold particular relevance to the content discussed in this article are collaborative learning and project/problem-based learning.

2.1.2 Project-Based Learning. **Project-Based and Problem-Based Learning (PBL)** are student-centered instructional approaches based on the belief that learning is most effective when immersed in real-life challenges. While many authors attempt to differentiate between the two concepts, Kolmos [2009] observes that both models persist in emphasizing the shared aspect of both concepts: learning organized around problems. In our research, we use the two concepts solely to differentiate the complexity level of the problems presented to students, ranging from minor challenges to a more complex project. The merits of this pedagogical approach are well-established [De Graaff and Kolmos, 2007]. Kolmos [2009] urged the broad institutional implementation of PBL methodologies, as they have the potential to address new learning outcome demands, contribute to a modern university profile attracting students, address funding issues by potentially reducing drop-out rates and improving on-time completion, and enhance overall learning quality for students. Fincher and Knox [2013] describe this instructional method as involving students in a prolonged and collaborative concentration on a particular project, typically revolving around a "driving question." The importance of physical space for the success of this approach is highlighted by Gary [2015], who notes that PBL excels in a learning setting that promotes collaboration and creativity. While there is no universally fixed definition of PBL, Krajcik and Blumenfeld [2006] propose that PBL methodologies, aside from focusing on a central question, also involve collaborative work guided by teachers to produce artifacts. In fact, according to Helle et al. [2006], project-based learning is considered a form of collaborative learning.

2.1.3 Collaborative Work. Baker [2015] notes that the emphasis on collaborative work arises from the need to teach students effective collaboration within and beyond school, especially in today's globalized world shaped by Internet technologies. Laal and Laal [2012] describe collaborative learning as an educational method that engages groups of learners in joint efforts to solve problems, accomplish tasks, or create products. In collaborative settings, students are grouped into smaller teams, where the group collectively determines task distribution by assigning shared responsibilities to all members or allocating specific roles based on individual skills and strengths [Araújo and Aguiar, 2023]. Nevertheless, Laal and Laal [2012] emphasize that in collaborative classrooms, traditional lecturing may not completely vanish; instead, it coexists with other processes rooted in students' discussions and active engagement with the course material. The consensus is that students working in small groups generally attain superior learning outcomes than those working individually on tasks [Van Leeuwen and Janssen, 2019]. Laal and Ghodsi [2012] point out numerous advantages of collaborative learning in their review article, including higher achievement and increased productivity when compared to traditional methods, as well as the fostering of more caring, supportive, and committed relationships, along with improvements in psychological health, social competence, and self-esteem.

2.1.4 Microlearning. In our research, the concept of microlearning stands out as a valuable tool. It involves short learning sessions strategically designed to promote effective knowledge retention. While initially associated with work-based learning [Hug, 2005], microlearning has demonstrated its versatility with successful implementations in higher education [Alias and Abdul Razak, 2023]. Key microlearning attributes encompass microcontent, a dedicated focus on a single definable idea or topic, and a brief learning duration [Buchem and Hamelmann, 2010]. Microlearning and

gamification are closely entwined concepts [Göschlberger and Bruck, 2017]. This approach has demonstrated its efficacy in enhancing motivation and actively involving students in the learning experience [Putri Septiani and Rosmansyah, 2021].

2.1.5 Learning by Doing. We have also integrated the concept of "learning by doing" into our course design. According to Reese [2011], learning by doing involves acquiring knowledge directly from personal experiences, in contrast to learning by observing others, reading instructions, or listening to lectures. Though it may be viewed as an older concept, this approach gains particular significance within the framework of our course design and training program. Here, participants initially immerse themselves in serious games, receiving theoretical instruction on the illustrated concepts only afterward.

The approach delineated in our research emphasizes integrating game-based learning, collaborative work, PBL methodologies, microlearning, and learning by doing. The overarching goal is to harness the motivational aspects, agency, and inherent creativity of game-based learning, microlearning, and learning by doing, combined with the improved and modernized teaching provided by PBL, while also tapping into the social and psychological dimensions, along with the heightened productivity facilitated by collaborative work.

2.2 Prior Work

Game-based training methods in industry can be notoriously difficult to find detailed documentation or credible references for. A well-known example is the "doggy daycare" exercise, a classic Scrum training activity referenced by Ken Schwaber in *Zen of Scrum* [Schwaber, 2004]. This activity suggests the creation of a marketing brochure for a fictional "doggy daycare" business to illustrate key agile principles—such as prioritization, teamwork, and adapting to changing conditions. Despite its popularity in workshops and trainings, the exercise remains largely undocumented in formal publications, making it hard for trainers and researchers to cite or replicate precisely.

In the realm of instructing agile methods or incorporating games, and in particular LEGO as an educational tool, as highlighted by Steghöfer et al. [2017], literature encompasses three main types of publications: (1) those dedicated to LEGO's role as a teaching tool, (2) the application of games and gamification techniques for teaching Scrum (a popular agile method we will be focusing on), and (3) works at the intersection addressing the use of LEGO in teaching Scrum.

Within the sphere of the pedagogical incorporation of LEGO, a body of literature is dedicated to exploring the application of Mindstorm products, a line of LEGO toys introduced in 1998, enabling the construction and programming of robots using LEGO blocks. These publications primarily address the teaching of engineering concepts [Behrens et al., 2009; Chraith and Kelly, 2010; Danahy et al., 2014; Gonçalves, 2017] and software development [Cuéllar and Pegalajar, 2014; Garcia and Patterson-McNeill, 2002; Lew et al., 2010]. Beyond higher education, LEGO has been applied in various contexts, ranging from its use in fostering musical and computational development in elementary school settings [Ludovico et al., 2017] to creating LEGO-based digital environments for teaching mathematical concepts like fraction ordering [Agbonifo and Ogunmoroti, 2015] and even extending to the instruction of chemistry concepts [Horikoshi, 2020].

Numerous publications have examined how to effectively teach Scrum principles, employing games or gamification techniques as instructional tools. Sibona et al. [2018] highlight the broad use of active learning approaches, exemplified by Tastycupcakes.org, a website with over 150 Agile game submissions, emphasizing practical and engaging methods for teaching Scrum in professional settings. For example, Naik and Jenkins [2019], among others, leveraged gamification by organizing students into teams, guiding them to formulate a strategic game plan for crafting a Trello Board tailored to a designated project case study. Subsequently, these teams engaged in a spirited game

competition, presenting their Trello Boards for evaluation and vying for enticing rewards. Fernandes and Sousa [2010] adopted a distinctive methodology for Scrum education. They introduced the PlayScrum card game, which transformed the learning process into a competitive game. In this scenario, each student assumed the role of a Scrum Master in a simulated software development project, adhering to Scrum practices throughout the gameplay. Brito and Vieira [2017] put forth a board game as a tool to enhance the practical teaching of Scrum, adding to the diverse spectrum of instructional methods available for imparting Scrum concepts. Lalić et al. [2021] examined the impact of game-based learning on master's students' understanding of agile project management using ScrumTale, a simulation game in which teams collaboratively create a story while practicing the Scrum framework.

The intersection of two distinct strands within educational practices involves the integration of LEGO as a tool for introducing Scrum methodologies. Several publications have explored the utilization of LEGO in educational settings to enhance the understanding and application of Scrum principles.

Paasivaara et al. [2014] introduced the Scrum LEGO Challenge as a pedagogical tool in the Software Project Management course at Aalto University. The challenge was central to one of the seven weekly face-to-face meetings in the 2012 and 2013 spring semesters. The course structure included 3–4 hour sessions, weekly assignments, and learning diaries based on guest lectures. Building on this trend, Bourdeau et al. [2021] employed a LEGO-Scrum **Simulation-Based Training (SBT)** in the "Information Technology Project Management" course at a North American university. This approach involved six teams, each with designated Product Owners. Two authors played pivotal roles in each SBT session, with one acting as an instructor, guiding the LEGO-Scrum SBT, and the other serving as an observer, documenting insights.

From a different perspective, Steghöfer et al. [2017] contributed to exploring LEGO in Scrum education by adopting workshops. The methodology used to teach Scrum in this study involves conducting LEGO workshops where students work in teams to build a LEGO city in short *Sprints*. The process includes introducing the workshop goal and Scrum concepts, creating a *Backlog* with user stories, estimating tasks using planning poker, executing sprints to build the LEGO city, and conducting *Sprint Reviews* and *Retrospectives*. Bica and da Silva [2020] used LEGO for a similar city-building activity consisting of four *Sprints*. Students were grouped into groups of 5 or 6 and constructed different city parts based on requirements. Feedback centered on the effectiveness of the classroom activity using LEGO blocks to teach Scrum concepts.

3 Method

This project received funding from the Support Program for Innovation Projects and the Development of Teaching and Learning, facilitated by Centro IDEA—a dedicated institution fostering innovation and advancing the development of teaching and learning methodologies at the University of Minho.

The research model adopted in this work is based on the **Design Science Research (DSR)** method [Hevner et al., 2004]. The research framework utilized in this study follows the DSR process outlined by Kuechler and Vaishnavi [2008], as illustrated in Figure 1. We have also considered the contributions of Peffers et al. [2007] regarding design research applied to information systems. As Gregor and Hevner [2013] describe, DSR entails crafting socio-technical artifacts. The choice of DSR for this research is grounded in its ability to encompass all necessary steps for developing a course design and training course aimed at teaching agile methods, from problem identification to evaluating the suggested and developed solution.

In adhering to this research method, we navigated through well-defined stages, commencing with identifying a problem—the need for making Agile Development education more engaging

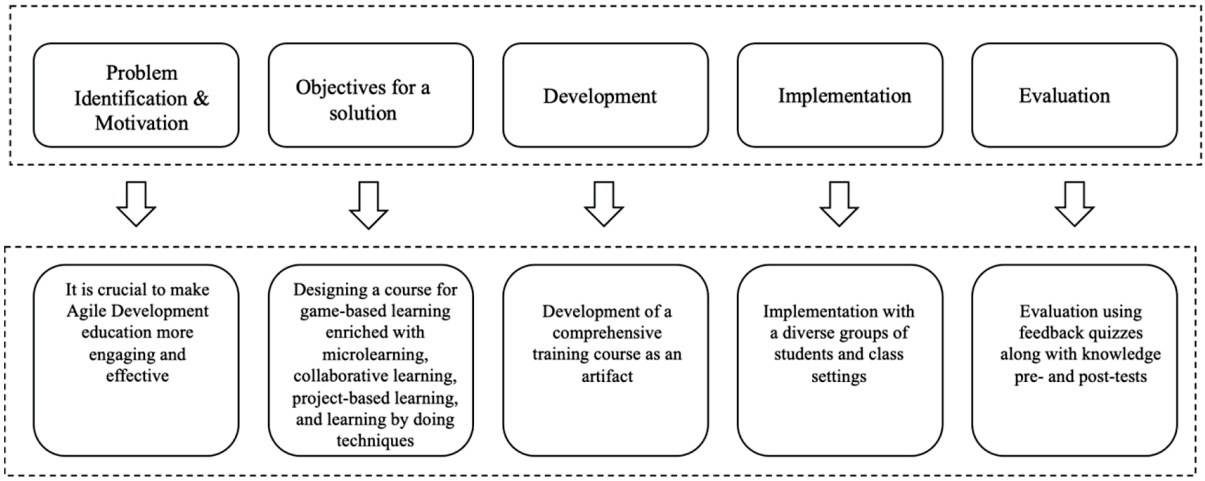


Fig. 1. Research method based on DSR. Adapted from Kuechler and Vaishnavi [2008].

and effective—followed by the proposal of a solution—designing a course for game-based learning infused with microlearning, collaborative learning, project-based learning, and experiential learning techniques, aimed at instructing agile development. Subsequently, we developed a comprehensive training course as our artifact and implemented and tested it in several practical courses with Scrum as the main agile framework. We assessed the training course and its design by utilizing pre- and post-course quizzes to gauge participants' knowledge levels.

3.1 Problem Identification and Motivation

ASD methodologies have become foundational in modern software development practices. As Baham [2019] emphasized, ASD is no longer a peripheral approach but a central paradigm in contemporary business environments. Its emphasis on flexibility, collaboration, and iterative progress has made it particularly attractive for both professional and educational settings. However, despite its widespread adoption, challenges remain, especially when ASD is implemented in educational contexts such as project-based student group work. According to Janes and Succi [2012], one recurring critique of Agile methodologies is their tendency to remain overly abstract and lacking in concrete guidance. This abstraction makes it difficult for novice practitioners, such as students, to effectively translate principles into actionable behaviors.

In practice, students frequently encounter specific issues when working in Agile teams. A systematic review conducted by López-Alcarria et al. [2019] revealed that students often struggle to form balanced teams with complementary skill sets, leading to poor group dynamics and uneven performance levels. Additionally, despite Agile's emphasis on flat team structures and shared responsibilities, some students assume dominant leadership roles, thereby undermining core Agile values such as collective ownership and self-organization. Communication breakdowns among team members have also been observed, according to the authors, further impeding collaboration and productivity. These issues highlight a critical gap between Agile theory and its practical application in educational contexts. Therefore, it is imperative to design a solution that can bridge this gap by providing students with a structured, yet engaging framework to better embody Agile principles in real-world team settings.

3.2 Objectives for a Solution

In light of the challenges identified in implementing ASD and Scrum methodologies within educational settings, there is a clear need for a structured and engaging learning experience that

effectively connects Agile theory with practical application. The proposed artifact is an open and reproducible course enriched with game-based learning, microlearning, collaborative learning, project-based learning, and learning-by-doing, which aims to address these challenges by employing active learning methodologies known to enhance student engagement and comprehension.

The primary objective of the course is to facilitate a practical understanding of Agile principles by immersing students in experiential, hands-on learning activities that simulate real-world team dynamics. Through these activities, students are expected to move beyond theoretical and abstract knowledge and develop the skills needed to apply Agile practices effectively in collaborative settings.

In response to recurring issues such as unbalanced team roles, dominant leadership behaviors, and poor communication, the course is designed to promote healthy team collaboration and self-organization. It incorporates collaborative learning strategies, structured role rotation, and reflective group tasks that encourage distributed responsibility and collective ownership. Game-based scenarios and microlearning modules will further support the development of essential soft skills, including communication, conflict resolution, and adaptive leadership within Agile teams.

Additionally, the course seeks to enhance student motivation and sustained engagement by integrating gamification elements and active participation. As highlighted in the literature review, previous studies [Brito and Vieira, 2017; Fernandes and Sousa, 2010; Lalić et al., 2021; Sibona et al., 2018] have demonstrated the effectiveness of game-based approaches in teaching Scrum and related frameworks, especially for novice learners. Finally, by ensuring the course is open and reproducible, the solution supports scalability and adaptability, allowing broader dissemination and iterative refinement across diverse educational contexts.

3.3 Development

The training course aimed to instruct participants in agile methods within the context of Information System Development, employing a game-based learning approach enriched with active learning techniques. During the initial preparation, the training underwent detailed planning, covering key topics and planned activities, acquiring essential materials and room reservations, and thoroughly preparing documentation. This documentation included creating slides, formulating practical assignments, developing a quiz, and designing a questionnaire soliciting student opinions on the training session.

The training course is structured into two integral segments. In the initial phase, participants delve into the foundational principles of agile development and Scrum through a dynamic blend of brief instructional sessions and engaging serious games. These tasks present participants with minor challenges, aligning with the principles of problem-based learning. They serve as a hands-on introduction to concepts that will be explored theoretically following each short serious game. Moving into the next phase, students collaborate in teams to extend their acquired knowledge through a larger project-based learning activity. This project, such as devising a racetrack or constructing a city, allows participants to apply and develop all the new skills grandly.

The first part of the training program covers key agile methodologies and Scrum concepts, encompassing the "agile" process, Scrum framework, roles like *Product Owner*, *Scrum Master*, and *Scrum Team*, along with Scrum artifacts (like *User Story*, *Product Backlog*, *Sprint Backlog*, *Increment*), and events (*Sprint Planning*, *Daily Scrum*, *Sprint Review*, and *Sprint Retrospective*). Additionally, participants familiarize themselves with essential techniques such as *Scrum Poker*, *Burndown Chart*, and *Kanban Board*. Appendix A presents the course's serious games in detail.

Additionally, the training schedule was defined, among other logistical aspects. This phase's comprehensive nature necessitated an estimated 40–50 hours. In the subsequent moment, execution, the training was structured into two sessions held on the same day, spanning a total duration of 8 hours. Throughout these sessions, observations were documented to gauge their efficacy.

3.4 Implementation

We implemented the training program with five groups in different contexts. The participants in the study represented a diverse mix of academic and professional profiles. Group 1, an open course cohort, included 12 participants: 4 students from the Master's in Information Systems (MSI), 4 bachelor's students from the Integrated Master's in Engineering and Management of Information Systems (MIEGSI), 3 PhD candidates from the Information Systems and Technologies program (PDTSI), and 1 university professor. Group 2, consisting of PhD students and an open course, involved 18 individuals: 8 PhD candidates from the Doctoral Program in Advanced Engineering Systems for Industry (AESI), 9 master's students from MIEGSI, and 1 professor. Group 3 comprised 19 students enrolled in the Master's in Engineering Project Management (MGPE). Group 4 included 20 students from the Master's in Technology and Innovation Management (METI). Lastly, Group 5 was a professional training module with 17 project management professionals from the ORG-PM (anonymized name), a research and development organization. The training sessions ran from 9:15 to 18:15 in a single day (for each group).

3.5 Evaluation

Before starting the training program, a quiz was administered to characterize the knowledge level of participants regarding Agile and Scrum. Toward the conclusion, the same quiz and a feedback questionnaire were administered to evaluate the evolution of the knowledge level and learning results. Additionally, a dedicated period of collective reflection was incorporated, facilitating the exchange of perspectives on positive aspects and improvement areas in future sessions. Some participants did not complete both tests due to arriving late to the training session or needing to leave early. This also explains why, in some groups, it was not possible to collect participation questionnaires from all individuals. Only responses in which both tests could be evaluated were considered. Tests and opinion questionnaires that were submitted blank were also excluded from the analysis.

Within this framework, the serious games were essentially cooperative activities focused on generating tangible results related to the covered topics. These tasks involved simulating services or creating physical artifacts, utilizing a range of materials (e.g., paper, scissors, glue, staplers, colored pens, post-its), and LEGO blocks. This method ensured that students were not just exposed to theoretical concepts on organizing project activities in their future professional engagements. Rather, they actively engaged in executing a project organized in an agile fashion, allowing them to deliver the specified products or services. This hands-on involvement provided practical experience and facilitated a well-rounded understanding of the benefits and constraints inherent in adopting agile methodologies for organizing project work. Every scheduled activity for the course was successfully carried out.

The obtained results were analyzed, taking into account observations from class sessions, completed tasks, the written exam (quiz), and feedback gathered during the collaborative reflection period. We concluded by ensuring the generalizability of our innovative solution for broader applicability in information systems agile development teaching contexts. We aimed to create a model that can be adapted and applied in various agile development teaching situations, promoting our innovative approach's effective and sustainable dissemination.

4 Results

4.1 Students' Feedback

The project's primary innovative aspects included incorporating serious games and gamification techniques to cultivate dynamic student participation and collaborative teamwork within the agile development of information systems. This approach minimized the duration of theoretical

exposition, ensuring that participants' attention remained consistently focused on the explored subjects throughout the classroom sessions. Aside from the initial minutes dedicated to expository content to establish a foundation in information systems development before transitioning to agile development, the subsequent training extensively utilized game-based methodologies. This pedagogical approach provided students with immediate hands-on experiences corresponding to the theoretical concepts discussed.

For a thorough evaluation of learning outcomes and the effectiveness of the session, we implemented two written quizzes and conducted a training feedback survey through a detailed questionnaire. Quizzes focusing on knowledge acquisition were implemented at the session's outset (pre-training) and conclusion (post-training). Students were informed about the quizzes only when they were prompted. Out of the 86 students from the 5 groups enrolled in the course, we gathered 75 complete and valid responses encompassing quizzes and 80 feedback questionnaires. This accounts for more than 87% of the participants and is succinctly summarized in the subsequent sections.

The three initial questionnaire questions (see Appendix B) were designed to gather additional information about the participants' typical behavior in the classroom. For the first question, "In your case, during traditional expository classes, do you typically adopt an active (participatory) or passive (observational, without intervening) approach?" (Q1), 61.25% of respondents described themselves as active participants, 31.25% as passive, 5% said it depends, and 2.5% gave other answers. Those who identified as active highlighted reasons such as the need to clarify doubts, deepen understanding, share ideas, and connect theory with practice. For example, one participant noted, "I tend to ask questions when I don't understand something," while another shared, "I like to contribute with examples from real situations to help contextualize the topic." In contrast, participants who reported a passive attitude often attributed it to the nature of traditional expository classes, which they described as less engaging and not encouraging interaction. Common reasons included a preference for listening and taking notes, fear of speaking in public, or feeling that the setting did not invite participation. One respondent explained, "I just prefer to listen and only speak if necessary," while another mentioned, "I stay quiet because I feel shy about asking questions."

Regarding the second question, "In a training environment incorporating serious games/gamification, do you feel encouraged to actively participate in the lessons?" (Q2), 91.25% of participants responded "more," while only 3.75% said "less," and 3.75% said "it depends." The reasons most frequently cited for increased participation included a more relaxed and informal environment, stronger interaction among participants, greater engagement through practical tasks, and a natural sense of inclusion and motivation. Many mentioned that games help reduce anxiety and encourage contribution by making the learning process more dynamic and enjoyable. For instance, one participant said, "With games, the atmosphere becomes more relaxed, and it's easier to ask questions and discuss opinions," while another noted, "Everyone participates, and there's closer interaction, which puts me more at ease."

For question 3, "With the integration of serious games/gamification, do you find yourself more attentive compared to traditional expository training?" (Q3), 91.25% of participants reported feeling more attentive, while only 5% felt less so. Participants attributed this increased attention to the interactive and engaging nature of gamified sessions, which reduces monotony and promotes active involvement. Many noted that physical activity and the need to stay alert to game dynamics help maintain their focus. For example, one said, "Being physically active allows me to stay focused longer," and another shared, "The continuous instructions in the game keep me paying close attention throughout the training."

We include nine questions in the survey to capture participants' viewpoints regarding the game-based approach.

For question 4, "In your opinion, learning the content of a course like this is more effective when: (…)" (Q4), the responses were as follows: 0% chose purely expository methods with passive participation; 6.25% favored expository methods with active participation through direct questioning; 90% preferred a combination of short expository segments with serious games/gamification involving active participation (the approach of our course); and 3.75% preferred gamification without expository methods. The majority who favored combining expository methods with gamification explained that this approach balances theory and practice effectively. Short expository periods introduce the concepts clearly without causing fatigue, while games help reinforce and consolidate learning by engaging students actively. Participants also highlighted that games promote interaction, making sessions more dynamic and less monotonous, which helps sustain focus. For example, one participant noted, "Short theory explanations keep us focused, and games help us better understand and clarify concepts." Another said, "The mixture of theory and practical games makes the learning process more engaging and easier to absorb."

For question 5, "Engaging in training with serious games/gamification is perceived as (responses: Less: 2.5%/More: 92.5%/Depends: 2.5%/Other: 2.5%) more captivating than training employing expository methods" (Q5). The main reasons participants found gamification more captivating were that it reduces monotony, increases interactivity, and requires active participation, which helps maintain attention and motivation. It also fosters teamwork and practical application of concepts, making sessions more dynamic and engaging. For example, one participant said, "Games force you to think and keep you involved, breaking the usual monotony." Another noted, "It's more fun and interactive, so I stay focused and enjoy learning more."

For question 6, "The integration of serious games/gamification enhances the classroom experience" (Q6), responses were: 1.25% said it worsens, 93.75% said it improves, and 5% said it depends. The main reasons given for why serious games improve the classroom experience include increased interaction and collaboration among students, a more relaxed and motivating atmosphere, and breaking the monotony of traditional expository teaching. For example, one participant said, "Games create a relaxed environment where everyone participates and time passes quickly." Gamification encourages active participation and practical application of content, which helps maintain attention, strengthen group cohesion, and improve learning outcomes. One participant noted, "It helps us understand theory better because we practice it and interact more with classmates and the teacher."

Regarding question 7, "Through the integration of serious games/gamification, lessons become more dynamic?" (Q7), 100% of participants agreed. They explained that serious games increase participation and interaction among students, breaking the monotony of traditional theory lessons. For instance, one participant noted, "It forces participation and interaction among themselves." The use of games fosters communication and teamwork, helping students apply concepts practically, as another said, "Yes, because it allows direct application of the concepts covered." Gamification also encourages students to take on different roles and keeps them engaged through competition and collaboration. Additionally, it promotes more interaction between students and teachers, enhancing engagement. Overall, participants highlighted that gamified lessons transform the traditional lecture into a more interactive and motivating experience, improving both engagement and understanding.

When participants were asked if "Serious games/gamification facilitate or make it difficult to have a clear understanding of the covered concepts" (Q8), an overwhelming 95% indicated that it facilitates understanding. They highlighted several key reasons, including the practical application of theoretical concepts, explaining that "putting into practice what was learned in theory helps to understand and memorize concepts." Participants also noted increased engagement and motivation, with one stating, "Because it's more practical, students are more attentive and motivated." Furthermore, the responses emphasized better retention and assimilation, as "the playful and practical character of games makes knowledge assimilation easier." Finally, the use of realistic

or real-life scenarios was frequently mentioned, with participants acknowledging that "games allow us to experience what is being taught more realistically."

Regarding the statement, "Serious games and gamification facilitate a swift understanding of the covered concepts" (Q9), the overwhelming majority of responses, 92.5%, indicated "More." Only a small fraction, 1.25%, felt it was "Less," while 2.5% said "It depends," and 3.75% chose "Other." Those who believed it facilitated a swifter understanding frequently cited the more immediate use of knowledge, noting that "they are applied immediately, turning the abstract into something concrete." Participants also highlighted increased engagement and attention, with one person commenting, "After years of expository courses, today I understood much faster thanks to this approach." The ability for faster identification of doubts was another key factor, as "questions arise more quickly and are clarified on the spot." Finally, the visual and dynamic nature of learning through these methods was emphasized, with one response stating, "Being a visual and practical training helps retention and comprehension."

When participants were asked if "Engaging in training with serious games/gamification is significantly more motivating than training primarily based on expository methods" (Q10), a resounding 97.5% found it more motivating, while none found it less so, and a small 2.5% believed it depended on the situation. The reasons cited for this increased motivation were numerous. Many highlighted the active participation and involvement that serious games foster, explaining that "the student feels they are applying theory and engaging in practice." The experience was also described as "more fun and less monotonous," with one participant noting, "It's more fun to play with LEGO than to read/listen to slides." Furthermore, the motivation stemmed from challenge and clear goals, as evidenced by the comment, "There's a real project to deliver, and people depend on me, which drives motivation." The approach particularly appeals to competitive or playful learners, with one individual remarking, "especially good for competitive people—there's a drive to do better than the other teams." Ultimately, this method encourages responsibility and ownership, transforming students into "active agents, not just spectators."

When participants were asked if "The utilization of serious games/gamification enhances your understanding of the essential aspects of the subjects being studied" (Q11), a significant 96.25% affirmed that it does. No one felt it did not, with a small 3.75% indicating it depends. Students frequently noted that these tools reveal real-world challenges and errors, explaining that "Through practice, we face problems that don't appear in theory and see possible solutions." They also emphasized how games make abstract ideas concrete, encourage deeper questioning and curiosity, and support discovery learning through mistakes, as one student put it: "We see errors, difficulties, and positive aspects we didn't expect—all of which help learning." However, it was also clear that games complement but do not replace theory, with a common sentiment being that "theory is essential, but games make it more engaging and productive."

Regarding question 12, "Does the utilization of serious games/gamification enhance your ease of understanding the subjects studied?" (Q12), 95% of participants responded affirmatively. Only a small fraction (1.25%) said no or that it depends (1.25%), with another 2.5% providing other responses. Students highlighted easier memorization due to active engagement, noting, "It's easier to retain knowledge when we use dynamic games." They also felt that games promote deeper reflection and analysis, stating, "When simulating a situation, we're forced to analyze the topic more deeply." Furthermore, the use of serious games makes theory tangible and applicable, as students observed, "We see how things work in practice—things that wouldn't be clear just from theory." Despite these benefits, many participants stressed that it needs theoretical support to be fully effective, emphasizing that "Games help, but they are not enough on their own—an explanation is always necessary."

From all the responses gathered, a consensus emerges regarding courses becoming more dynamic, interesting, and motivating, aiding students in comprehending the subjects more easily.

The final set of six questions was specifically targeted at the particular circumstances of the conducted training.

Regarding question 13, which asked participants to identify primary skills cultivated through the training, excluding those directly related to the training itself (Q13), several key abilities emerged. Participants frequently cited an improvement in teamwork, with one individual remarking, "I learned to work better in a team and be more organized." Closely related skills like organization, communication, leadership, interpersonal relations, and collaboration were also prominently mentioned. Furthermore, the training was seen as fostering critical thinking and creativity, as evidenced by the comment that "The games allowed for decision-making discussions and the development of critical thinking." Finally, proactivity was also highlighted as a cultivated skill.

When asked about their favorite aspects of the training, aside from the subject matter itself (Q14), participants frequently highlighted the involvement in various activities and dynamics. One participant enthusiastically stated that "The way it integrated games and subject matter, I think it was the best class of my entire master's degree." Teamwork was another highly praised element, with comments such as, "Teamwork, because I worked with new people and everyone was willing to collaborate." The clarity of instruction was also appreciated, with participants noting "The trainer's good ability to captivate the attention of the trainees." The seamless articulation of theory and practice was a significant draw, as was the active participation encouraged, with one individual mentioning "The participation required, but without feeling obliged to do so." The quality of the pedagogical materials provided also received positive feedback. Finally, the simulation of a real project was a particular favorite for many, with one participant remarking, "The last project was very complete and interactive."

When asked what they liked least about the training (Q15), participants primarily mentioned the evaluation forms, the length or duration of the training, and the lack of organization of materials used in the activities (mainly the LEGO blocks, since they are all mixed in a large box).

When participants were asked if they "experienced any difficulties during their training" (Q16), 55% reported no difficulties, while 42.5% indicated they did, and 2.5% gave other responses. Among those who faced challenges, several recurring themes emerged. Many participants felt time pressure to complete tasks, describing "constant pressure to meet objectives in short timeframes." Another common difficulty was understanding and assimilating numerous concepts, with some noting that "several topics were covered that need more time to be fully understood." Team coordination also posed an issue for some, as one participant mentioned, "At certain points, my team was very dispersed." Practical challenges, such as finding required materials, were also cited, with one person stating, "Finding the LEGO small pieces was a challenge." Additionally, some participants experienced difficulty adapting to new or unfamiliar learning environments, grappling with "combating initial inertia due to lack of contact with this learning approach." Finally, role clarity and task comprehension presented initial hurdles, with one participant claiming: "Until we understood what the teacher really wanted, it was a bit confusing."

When participants were asked about their preferred session format for future training (Q17), an overwhelming 90% opted for a combination of short expository sessions and serious games/gamification. A mere 5% chose sessions primarily featuring serious games/gamification, and none preferred purely expository sessions, with the remaining 5% selecting other formats. The strong preference for a blended approach stems from several perceived benefits. Participants emphasized that better comprehension and retention are achieved this way, with one noting, "Sessions with exposition are fundamental, but the games are essential to solidify the exposed knowledge." They also highlighted that the theory provides the necessary foundations for practice, explaining, "it's

always important to have a more theoretical part to understand what is going to be applied in the games." This combined format was also seen to motivate and sustain attention effectively and support progressive learning, as one participant suggested that "It's a good idea that sessions start with short theory and then move into practical games for effective understanding." Finally, the blend was considered essential for contextualization, with the view that "a brief explanation of the purpose and usage helps better apply the concepts in practice."

When asked for suggestions to improve the training (Q18), participants primarily recommended extending the training duration, with one stating, "The training should last two days so we can have a greater practical component." Conversely, there was also a suggestion to shorten the final activity, as one participant felt, "the last game should be shorter and more focused since it's tiring."

The training garnered informal feedback from one participating fellow teacher, who expressed a positive response on social media. The colleague likened the training to a "learning Spin bike session," emphasizing the engaging and rich nature of the experience.

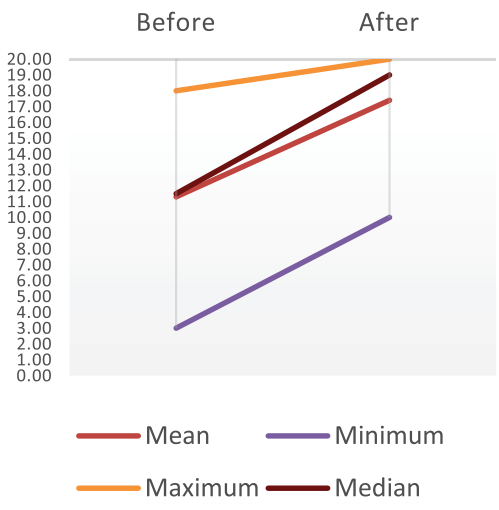
4.2 Learning Results

The evaluation was conducted not solely through student feedback and direct observation but also by administering two quizzes (without consultation) featuring identical questions. The quiz comprised 30 questions, allowing students to respond with "true," "false," or "I don't know (?)." For individual scoring, each correct answer was awarded 1 point, each incorrect answer resulted in a deduction of 2 points, and unanswered questions had no impact on the final score. The graph pictured in Figure 2 depicts the pre-training and post-training results, showing the students' average, median, minimum, and maximum scores for each group. The figure shows a significant increase in the average grade post-training. This is particularly noteworthy if we compare the grade mean before and after the training.

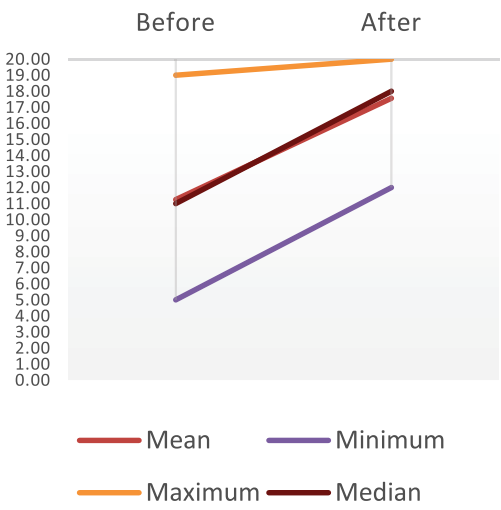
It is worth noting that, in the case of Group 2, the training was conducted with the same course, employing both a traditional expository approach and the proposed method. The course, part of an integrated Master's program and comprising 23 students, was divided into 2 subgroups. Nine students volunteered to participate in the gamified training, while the remaining 14 students, forming the control subgroup, received traditional lectures. Identical assessment tests were administered to both subgroups. For the gamified training, nine complete responses were collected (i.e., two tests per participant), whereas for the conventional training, 11 complete responses were obtained. As shown in Figure 3, the average scores achieved using the new approach were nearly three points higher than those obtained with the traditional method, providing significant evidence of its practical effectiveness. However, it is important to acknowledge the potential bias in the results due to the self-selection of students who volunteered for the gamified training, which may have influenced the subgroup characteristics.

5 Discussion

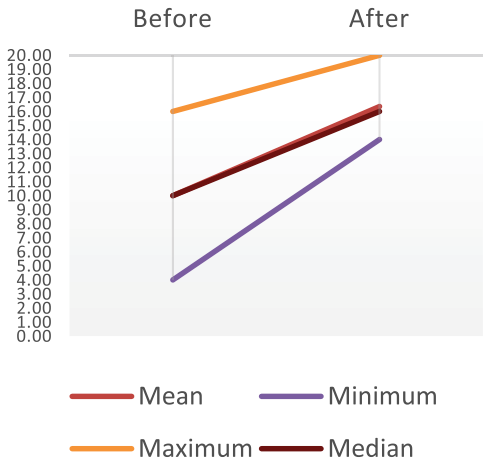
A primary inference derived from the training evaluations is the overwhelming preference of students for sessions incorporating short expository segments with serious games or gamification elements. This finding aligns with the research conducted by Bica and da Silva [2020], which demonstrated that over 85% of students perceive learning Scrum through activities like LEGO City to be more effective compared to traditional methods such as lectures, slides, and theoretical classes. Other studies also indicate a preference for game-based learning over traditional teaching approaches. Hartt et al. [2020] showcase in their research that, when given the choice, students generally lean towards game-based learning over the conventional lecture-based instructional method.



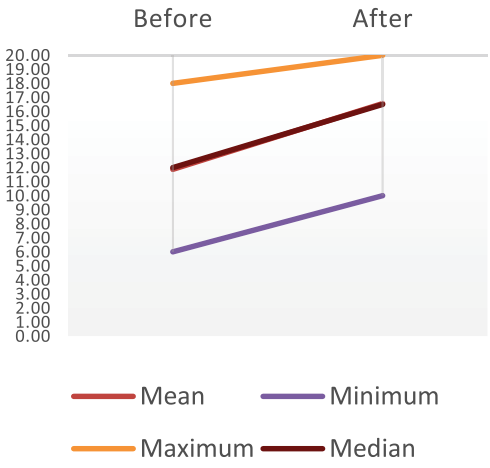
Group 1



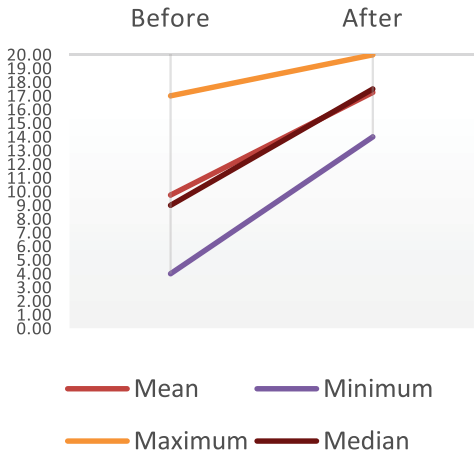
Group 2



Group 3



Group 4



Group 5

Fig. 2. Grades per exam (before and after).

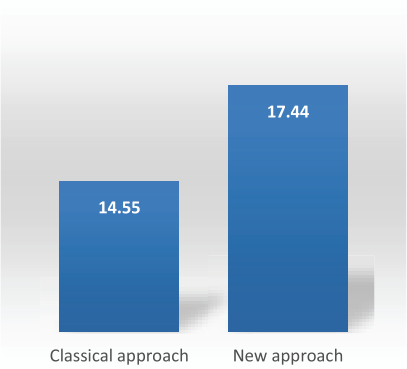


Fig. 3. Mean of grades in Group 2 (after)—classical approach (control subgroup) vs. new approach.

With regard to cultivated skills, when responding to open-ended questions, many students emphasized the enhancement of key abilities such as teamwork, organization, communication, leadership, interpersonal relations and collaboration, creativity, and critical thinking. This finding is consistent with the observations made by Steghöfer et al. [2017], who reported an elevation in self-assessed confidence among students in terms of communication as a whole. Moreover, Paasivaara et al. [2014] emphasized that a considerable number of students identified teamwork and communication within their respective teams as the most crucial skills they acquired.

Additionally, some mentioned the acquisition of "leadership" and "creativity" skills. These soft skills are crucial for an information systems professional [Sampaio et al., 2022], and they attested their ability to enhance these skills during the training. In their review, Qian and Clark [2016] examined the literature concerning the influence of game-based learning on the cultivation of 21st-century skills. They found that out of the 29 studies analyzed, only one provided findings on communication, and a limited number delved into creativity. This is noteworthy as creativity holds significance in global curricular frameworks emphasizing 21st-century learning models. Moreover, creativity plays a vital role in the skill set required for well-rounded project management students [Pires and Varajão, 2024].

The learning results are also consistent with Bica and da Silva's [2020] study, where the percentage of students rating their knowledge levels as 1, 2, or 3 decreased from 74.5% before the workshop he carried out to 8.5% afterward. Meanwhile, those rating their knowledge as high (4) or very high (5) increased from 25.5% to 91.5%, indicating a significant improvement in understanding following the workshop.

Building upon the insights presented in the preceding sections, it is evident that the obtained results are notably positive. However, it is needed to acknowledge that this approach is not devoid of its challenges. Two prominent challenges are associated with organizational and logistical aspects. While the training demonstrated success, it necessitated a full-day duration in a singular physical space, a requirement that may not always align with the infrastructures and schedules established for classical courses. Furthermore, it demands more extensive resources and space compared to traditional courses held in venues like an auditorium, which could pose a hurdle, particularly in the context of larger class sizes.

Within the conducted training, serious games and gamification emerged as highly effective tools in the teaching-learning process. Notably, these methods proved to be resource-efficient, with minimal consumable expenses—estimated at less than 0.50 Euro per student for the entire course—given the reusability of several materials. The cost associated with reusable materials (such as LEGO blocks, plastic boxes, scissors, staplers, tennis balls, and cases for storing materials) amounted to around 700 euros.

It is important to acknowledge that the element of "novelty" in these methodologies serves as a potential motivational factor. Therefore, the extensive use of serious games and gamification, if deemed "massive," may pose a risk to the effectiveness of the process, as the novelty effect might diminish over time.

The proposed approach may not be universally suitable for all courses, and it is advisable to conduct experimentation before actual implementation. A free course context provides an interesting setting for such experimentation, offering the opportunity to assess the planned strategies' effectiveness and identify areas for enhancement before potentially impacting regular curricular units.

In summary, the training course proved to be a highly motivating and rewarding experience for both students and lecturers, despite its physical demands (especially for the instructors, at least in the format we attempted, involving approximately 11 consecutive hours, encompassing logistics preparation, 8 hours of training, and breaks).

Lastly, to highlight that our approach to instructing agile methods diverges from other training endeavors, even those with a shared goal of constructing a project such as a city. What sets our work apart is the intercalation of game-based learning and the teaching of theoretical concepts in short expository segments, followed by a long activity to put all the concepts into practice. This innovative approach is grounded in principles such as learning by doing [Reese, 2011], collaborative learning [Laal and Laal, 2012; Van Leeuwen and Janssen, 2019], and microlearning [Buchem and Hamelmann, 2010; Göschlberger and Bruck, 2017]. It involves introducing theoretical concepts through short serious games [Becker, 2021; Laamarti et al., 2014] that illustrate the ideas, followed by their systematic exposition in concise informational segments. In contrast, other works either assume participants possess basic knowledge of agile methods, as seen in Paasivaara et al. [2014], or provide an initial introduction that does not incorporate game-based learning, as exemplified by Steghöfer et al. [2017]. Games should be thoughtfully designed to captivate learners, as emphasized by Qian and Clark [2016], but, notably, not all studies align their games with established learning approaches. The integration of Scrum learning with elements of LEGO introduces a valuable interdisciplinary contribution. There is an established body of literature on LEGO-based learning, including the use of LEGO Mindstorms in STEM and computer science education. The approach outlined in this study lays important groundwork for future expansion in that direction. For instance, game-based Scrum activities could be further developed using LEGO robotics or more complex engineering problem-solving scenarios, enhancing their relevance and appeal for Computer Science and STEM-focused curricula. While game-based approaches to Scrum training are known within industry practice and gray literature, they are often undocumented, inaccessible, or difficult to cite within academic contexts. This article contributes to the field by bridging that gap, offering a structured, openly available, and pedagogically grounded set of game-based learning resources tailored for Scrum education and for information systems education. Furthermore, the use of a DSR approach, combined with clearly defined evaluation criteria, introduces a systematic and reflexive method for testing and refining teaching instruments. This evidence-based methodology distinguishes the work from industry practices, where such iterative evaluation and theoretical grounding are often absent. Overall, our approach contributes to theory, practice, and teaching by combining different principles in the same course design, strengthening the learning process.

6 Conclusion

This article introduces a training approach and course that utilizes game-based learning for education in information systems agile development. Beyond detailing the implemented process, the article also presents and discusses the obtained results, aiming to facilitate the replication of the implemented practices. The key outcomes encompassed heightened effectiveness in the teaching-learning process, accelerated comprehension of involved concepts, more dynamic classes,

increased student motivation for covered topics, and an overall enhancement in the classroom experience. In essence, the endeavor succeeded in elevating the quality of learning and fostering educational success.

Limitations inherent in this study, as well as in related research, arise from the challenge of incorporating the proposed method into a conventional classroom setting. Two key factors associated with traditional classrooms contribute to this complexity. Firstly, our study involved a limited number of participants, whereas traditional courses may involve a larger student population. Managing a substantial number of participants poses a barrier to the method's integration. Additionally, the temporal distribution of content presents a hurdle. Our method is tailored for an immersive learning schedule. Replicating activities such as the "big" project, with an estimated duration of four hours, becomes intricate in an environment where students attend, for instance, two-hour classes once a week. This constitutes a significant concern, warranting exploration in future research. One potential avenue for investigation involves the coexistence of traditional courses alongside more intensive sessions. For future endeavors, we also strongly endorse the implementation of the outlined processes and methodologies, not only within similar courses but also across diverse areas and subjects.

In summary, it is highly recommended to give *serious consideration* to the incorporation of *serious games* and *gamification* in higher education, but not neglecting the importance of expository training in correct doses!

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Appendix A

The first serious game (Table A1) of the course, titled "Elephant Pet House Project," introduces the concept and advantages of an *Agile* approach. It achieves this by illustrating the drawbacks of the conventional *Waterfall* approach. The waterfall approach highlights a sequential progression from project start to finish, but faces the issue of not tackling changes in requirements well as the project advances. The game's objective is for participants to grasp the advantages of an agile process in specific contexts. Participants collaborate in teams on a "six-month" project, each minute symbolizing one month of the project timeline. Their task involves constructing a dwelling for a pet elephant, complete with precise requirements. They need to build a door with precisely 5 mm of margin, a window, and a classic roof for the interior. On the exterior, they must build a drinking fountain and a litter box. The instructor initially presents a small elephant, and the teams can measure it with a ruler.

Near the end of the game, the instructor replaces the small elephant with a much bigger one without the teams noticing it. At the end of the game, the instructor asks teams to present their results. Of course, when the elephant is presented again, due to its "growth" ("six months" after the beginning of the project), it can no longer fit through the door and enter the built dwelling. This game aspect aims to demonstrate the dynamic nature of project requirements and emphasizes the importance of continuous client-team communication, an essential aspect of agile methods.

The following three games are connected to the primary roles in the Scrum framework, specifically, the *Product Owner*, *Scrum Master*, and *Scrum Team*. For instance, the game titled "The Super-Secret Vehicle" (Table A2), demonstrates the *Product Owner*'s involvement and importance in decision-making and its impact on the final product. During this activity, participants collaborate in teams to create a "confidential" vehicle within a five-minute timeframe. Each team is assigned a *Product Owner* responsible for providing instructions on specific features of the vehicle, such as a boat, an airplane, or a six-wheeled car. Upon completion, the teams showcase their "secret" vehicles and explain the unique reasons that make their creation exceptional. The outcomes will vary significantly among the teams, showing the role and importance of the *Product Owner*.

In the interactive activity "Pass the Ball!" (Table A3), the objective is to exemplify the responsibilities of the *Scrum Master*. The setup involves a bucket filled with plastic balls at the starting point and an empty bucket at the conclusion. Participants are arranged in a line and must transfer the balls from the initial bucket to the empty one. Importantly, they can only pass one ball at a time, and if a ball drops, it must be returned to the starting point and cannot proceed to the next participant. The game unfolds in two timed stages. Initially, participants engage in the first phase without supervision. As the game advances, the participants start passing the balls in a less

Table A1. Serious Game 1—Elephant Pet House Project (Agile Process)—Summary

Serious Game Title	The Elephant Pet House Project
Learning Focus	Introduction to the concept of an agile process through practical application.
Material	LEGO blocks, ruler
Duration	10 minutes
Game Dynamics	The teams face the challenge of creating a pet house with particular specifications. However, midway through the game, the requirements shift due to the elephant's "growth transpose."

Table A2. Serious Game 2—The Super-Secret Vehicle (*Product Owner*)—Summary

Serious Game Title	The Super-Secret Vehicle
Learning Focus	Emphasizes the role and decision-making of a *Product Owner*.
Material	LEGO blocks
Duration	10 minutes
Game Dynamics	Teams create a "super-secret" vehicle in 5 minutes, each with a different *Product Owner*.

Table A3. Serious Game 3—Pass the Ball! (Scrum Master)

Serious Game Title	Pass the ball!
Learning Focus	Illustrates the importance of a Scrum Master in facilitating team processes, emphasizing efficiency and collaboration within a time constraint.
Material	Plastic balls, two buckets (or any type of recipient)
Duration	10 minutes
Game Dynamics	Teams engage in the game with and without a Scrum Master, featuring a timed challenge.

coordinated manner, resulting in instances of clumsiness, with balls being dropped and valuable time spent promptly retrieving them. In the latter phase, one individual assumes the role of *Scrum Master*. In this capacity, they oversee the proceedings, guiding their colleagues. For instance, they might advise against immediately retrieving fallen balls and instead suggest waiting until the end to gather them all. Alternatively, they may offer tips on improving the ball's grip with both hands to minimize the risk of dropping it. With the *Scrum Master*'s involvement, as expected, the process becomes more efficient and takes less time to complete.

The game, known as "The Tri-Quest Challenge" (Table A4), seeks to illustrate the concept of a *Scrum Team*. Participants collaborate in teams, and each team takes on three tasks with different levels of difficulty: a straightforward task involving transporting balls, a moderately challenging task of building a tower (as high as possible) with six A4 sheets capable of standing for at least 10 seconds, and a complex task involving constructing a LEGO tower with 50 levels. The teams are organized into two distinct structured types and compete against each other. In one type (Team 1), each member is exclusively assigned a single task. This means participants focus solely on their assigned task and, upon completion, wait for their teammates to finish (they cannot help each other). This format results in participants with more straightforward tasks completing their work quickly, while those with more complex tasks are left feeling overwhelmed. Contrastingly, when a team member completes their task in *Scrum Teams*, they actively assist their colleagues in finishing their respective tasks. This collaborative approach, put into practice by Team 2, enhances efficiency and speed in completing the overall project. The game effectively illustrates the concept of a *Scrum Team* as a supportive and interdependent unit, emphasizing the benefits of teamwork.

In the "The Six-Story Building Project" game (Table A5), participants engage in a "three-month" project where they form teams to construct a six-story building. The game illustrates key concepts

Table A4. Serious Game 4—The Tri-Quest Team Challenge (*Scrum Team*)—Summary

Serious Game Title	The Tri-Quest Team Challenge
Learning Focus	Explores dynamics within a *Scrum Team*, demonstrating how task distribution and teamwork influence successful assignment completion.
Material	Plastic balls, A4 sheets of paper, LEGO blocks
Duration	10 minutes
Game Dynamics	The teams engage in three tasks with differing levels of difficulty. While some teams execute the tasks individually, *Scrum Teams* approach the tasks collaboratively.

Table A5. Serious Game 5—The Six-Story Building Project (Scrum Concepts)—Summary

Serious Game Title	The Six-Story Building Project
Learning Focus	Covers the concepts of *User Story*, *Product Backlog*, *Sprint Backlog*, *Increment*, and *Kanban Board.*
Material	LEGO blocks
Duration	15 minutes
Game Dynamics	Teams embark on a 3-month project, breaking it down into three sprints, intending to construct a six-story building.

such as *User Story*, *Product Backlog*, *Sprint Backlog*, and *Increment*. Throughout the project, the instructor assumes the role of the *Product Owner*. Each floor of the building corresponds to a *User Story*, detailing the specific requirements for that floor. The teams employ a *Kanban Board*, categorizing tasks into "to do," "doing," and "done." The *Product Backlog*, representing the set of *User Stories*, is initially placed in the "to-do" column. In this game, the floors are depicted as rectangular LEGO blocks of distinct colors (e.g., white for floor 1, purple for floor 2). The project is divided into three *Sprints*, and during each *Sprint*, the *Product Owner* chooses the *User Stories* to be accomplished. These *User Stories* transition from the "to-do" list to the "doing" list, forming the *Sprint Backlog*. Upon completing each *Sprint*, the delivered result constitutes an *Increment*. This iterative process continues through subsequent *Sprints* until the conclusion of the "3-month" project.

In the sixth game, titled "The Modular House Project" (Table A6), participants explore the main Scrum events while constructing a modular house. In the collaborative effort, participants form teams, with the instructor assuming the role of the *Product Owner*, aiming to construct a modular house. The project entails various requirements, such as a master bedroom, guest room, common bathroom, private bathroom, swimming pool, chicken coop, kitchen, living room, office, and laundry room, with the primary objective of enabling the client to move in promptly. Throughout the game, participants actively engage in key Scrum events. *Sprint Planning* serves as a joint session at the onset of each *Sprint* to prioritize rooms for the client's swift occupancy. Midway through the *Sprint*, the instructor initiates a *Daily Scrum*, a standing meeting where team members provide progress updates, address challenges, and coordinate their efforts. Upon completing the *Sprint*, the trainer conducts a *Sprint Review*, during which team members showcase their work to the *Product Owner* for feedback on its alignment with the initial decisions. Additionally, a *Sprint Retrospective* takes place to discuss process improvements, such as determining that gathering all needed LEGO blocks

Table A6. Serious Game 6—The Modular House Project (*Scrum Events*)—Summary

Serious Game Title	The Modular House Project
Learning Focus	Practical application of Scrum events in the context of a construction project (*Sprint Planning, Daily Scrum, Sprint Review,* and *Sprint Retrospective*).
Material	LEGO blocks
Duration	20–30 minutes
Game Dynamics	Teams have to build a modular house by participating in Scrum events.

Table A7. Serious Game 7—Scrum Poker—Summary

Serious Game Title	Scrum Poker
Learning Focus	Applying the *Scrum Poker* estimation technique in practical scenarios.
Material	Plastic balls
Duration	5 minutes
Game Dynamics	Teams employ *Scrum Poker* techniques to estimate the effort required for transporting plastic balls.

at the beginning is more efficient than picking up pieces one by one. These events are reiterated until the entire house is constructed.

In the sixth activity, "Scrum Poker" (Table A7), the enrolled students participate in an estimation exercise to identify the required effort for carrying out tasks. The estimation adopts the Fibonacci sequence, recognizing the non-linear nature of effort and accounting for fatigue throughout the process. According to Alsaadi et al. [2021], *Scrum poker*, also known as *Planning Poker*, is an estimation technique employed within Scrum framework. Initially, the *Product Owner* elucidates *User Stories*, after which team members designate estimation values using cards for each story. These estimation values, referred to as *Story Points*, may be allocated through approaches such as the Fibonacci sequence or t-shirt sizing. Our proposed game aims to enhance the team's estimation abilities by evaluating the effort needed to transport a specified number of balls (one at a time). Points are awarded for successful completions across various levels, including 1 ball, 5 balls, 7 balls, 15 balls, and 30 balls. This way, participants realize that the time of transporting 15 balls is higher than 15× the time of transporting one ball.

In the second phase of the training, participants apply the knowledge gained earlier by collaboratively developing a large-scale project (Table A8)—such as a racetrack or city—intended to simulate real-world complexity. This project-based activity emphasizes experiential learning, enabling participants to engage with Agile concepts on a broader and more dynamic level.

The project is introduced with a presentation in which the instructor, acting as the *Product Owner*, outlines the scope (e.g., a city) and works with participants to define and prioritize project requirements. These requirements are expressed as *User Stories* written on post-its, following the format: stakeholder + purpose + motivation (e.g., "As the mayor, I need a hospital because the community requires medical care"). Each *User Story* is assigned a priority by the *Product Owner*. Then, the instructor assigns a set of *User Stories* to each team.

Table A8. Serious Game 8—The "Big" Project—Summary

Serious Game Title	The "Big" Project (e.g., "racetrack," "city")	
Learning Focus	The "big" project focuses on the practical application of agile and Scrum roles and techniques.	
Material	LEGO blocks, Paper sheets, Plastic Balls, Scissors, Glue, Staples, etc.	
Duration	4 hours	
Game Dynamics	Teams collaborate to develop the project.	*"Family photo" of Case 1*

The project is carried out across several *Sprints*, typically three to four sessions of 30 minutes each. Before each *Sprint*, teams conduct planning sessions (*Sprint Planning*) where they estimate the effort of requirements using *Scrum Poker* (with a mobile app). Teams organize their work using a *Kanban Board*, which includes the columns: Backlog (team), Pending (*Sprint backlog*), In Progress, Completed–Awaiting Review, and Completed–Accepted by the *Product Owner*. A *Burndown Chart* is maintained in parallel to track progress. Each team operates within its own designated area, where all tools and visual aids are visible and continuously updated under the trainer's supervision.

Throughout the activity, participants simulate *Daily Scrums* every 10 minutes to reflect on team progress. At the end of each *Sprint*, the *Product Owner* reviews the deliverables to ensure they meet quality standards and align with requirements. Items that fall short are returned for further development in the following *Sprint*. A *Sprint Retrospective* is also held, allowing each team to evaluate what worked well and what needs improvement. At the end of each *Sprint*, the instructor asks teams to alternate the *Scrum Master* so everyone can get the experience, and distribute a new set of *User Stories* to teams.

To keep the project engaging and simulate real-world unpredictability, the instructor may introduce challenges such as adding or modifying requirements, reshuffling team members, or forming specialized task forces. These groups may be tasked with more complex objectives, like programming LEGO Mindstorms using low-code tools.

As the project progresses, new requirements are added, while unmet ones are carried over into the next *Sprint's Backlog*. Teams must keep their *Kanban Boards* and *Burndown Charts* up to date, as accurate documentation is essential for evaluation. At the project's conclusion, each team presents its work, and the final outputs are assessed against the initial requirements and Agile documentation.

Appendix B

(Q1) In your case, during traditional expository classes, do you typically adopt an active (participatory) or passive (observational, without intervening) behavior? Please justify your answer.
(Q2) In a training environment incorporating serious games/gamification, do you feel *less/more* encouraged to actively participate in the lessons? Please justify your answer.
(Q3) With the integration of serious games/gamification, do you find yourself *less/more* attentive compared to training sessions primarily characterized by exposition? Please justify your answer.

(Q4) In your opinion, learning the content (of a course like this) is more effective when: (1) Expository methods are utilized, and students participate passively, without direct questioning; (2) Expository methods are utilized and students participate actively, with direct questioning; (3) Expository methods (in short periods) are used in conjunction with serious games/gamification practices, and students participate actively through games; (4) Serious games/gamification practices are used without resorting to expository methods, and students participate actively through games; (5) Other. Please justify your answer.
(Q5) Engaging in training with serious games/gamification is *less/more* captivating than training employing expository methods. Please justify your answer.
(Q6) The integration of serious games/gamification *worsens/improves* the classroom experience. Please justify your answer.
(Q7) Through the integration of serious games/gamification, lessons become *less/more* dynamic. Please justify your answer.
(Q8) Serious games/gamification make it *difficult/facilitate* a clear understanding of the covered concepts. Please justify your answer. Please justify your answer.
(Q9) Serious games and gamification make it *difficult/facilitate* a swift understanding of the covered concepts. Please justify your answer.
(Q10) Engaging in training with serious games/gamification is *less/more* motivating than training primarily based on expository methods. Please justify your answer.
(Q11) Does the utilization of serious games/gamification enhance your understanding of the essential aspects of the subjects being studied? Please justify your answer.
(Q12) Does the utilization of serious games/gamification enhance your ease of understanding the subjects studied? Please justify your answer.
(Q13) Please identify the primary skills you believe have been cultivated through this training, excluding those directly associated with the training itself.
(Q14) What did you like MOST about the training? (Apart from the subject matter)
(Q15) What did you LEAST like about the training?
(Q16) Did you experience any difficulties during your training?
(Q17) In an upcoming training, if you were given the choice of session format, which one would you choose? (1) Expository sessions; (2) Sessions with serious games/gamification; (3) Expository sessions (short periods), in conjunction with serious games/gamification; (4) Other. Please justify your answer.
(Q18) What suggestions would you like to make to improve the training?

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