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The Use of Gamification for Learning SCRUM: Findings from a Case Study with Information Systems Students

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Abstract: Gamification has emerged in higher education as an innovative approach that engages and stimulates student participation and active learning, through the integration of game elements in the learning experience. This study presents a case study in the field of Information Systems, based on the use of gamification, through the use of Lego bricks, to learn SCRUM. The participants in the study include 12 first-year students, enrolled in the curricular unit of Information Systems, in the academic year of 2022/2023, at a Portuguese Higher Education Institution. The objective of the study is to analyze student's understanding of the SCRUM approach, in regard to: (1) how students understand the different roles of SCRUM and the objective of each ceremony; and (2) how students understand the structure of the SCRUM framework. Findings from the study show that students who engaged in the gamified learning environment demonstrated higher comprehension of SCRUM roles, scoring significantly better on assessments compared to their non-participating peers. In general, students felt that the gamification experience achieved its objectives. Future work aims to bring the game closer to the reality of the software development process, making it more aligned with the lego4scrum methodology approach.

Keywords: active learning; gamification; information systems; SCRUM; Lego

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1. Introduction

Gamification in higher education has emerged as an innovative approach to engaging and motivating students, integrating game elements and principles to enhance the learning experience [1]. The state of the art in this field showcases a growing recognition of its potential to transform traditional education methods. In recent years, educators have increasingly incorporated gamified elements into their courses, from online quizzes and leaderboards to more immersive experiences that blend educational content with interactive gameplay [2–4]. This shift reflects a broader acknowledgment that gamification can foster active participation, problem-solving skills, and a deeper understanding of complex subjects. Moreover, it aligns with the modern student's desire for dynamic and interactive learning experiences. The state of the art also involves the integration of technology, such as virtual reality and mobile applications, to create more immersive and personalized gamified educational experiences, catering to a diverse range of learning styles [2].

Furthermore, researchers have been actively exploring the impact of gamification in higher education, examining its effectiveness in improving student motivation, retention, and learning outcomes [2]. Studies have shown that well-designed gamified elements can lead to increased student engagement, a better comprehension of course materials, and a heightened sense of accomplishment [5,6]. Gamification research continues to evolve, with a focus on refining the design of gamified educational content, evaluating its long-term effects on student learning, and exploring the optimal balance between challenge and

reward. Dey and Eden [7] conducted an archival analysis from 2008 to 2015 to identify trends in gamification research. They found that most research was in the education context, and highlighted the growing interest in the field, suggesting that gamification research is in its infancy. This is also confirmed by Thongmak [4], who pointed out the limited understanding of gamification in education and its implementation. Their study demonstrated the positive effects of implementing gamification in classroom environments on students' perceived usefulness and engagement intention, offering guidance for easy implementation.

In the field of Information Systems education, gamification has gained considerable attention in recent years due to its potential to enhance student engagement, promote active learning, and align educational practices with the evolving needs of the digital generation [8,9]. The state of the art in this domain reveals a significant shift towards using gamified strategies to engage and educate students effectively. Authors such as [3,6,10,11] have discussed some of the main challenges and advances in the field. Schlagenhaufer and Amberg [10] conducted a literature review to address the lack of comprehensive research on gamification in Information Systems. They created a classification framework and analyzed prior literature to establish a foundation for future research and a structure for gamification research. Swacha [6], in turn, reviewed ten years of research on Information Systems gamification. They investigated the changes in interest, geographic spread, research character, and scope, discussing advances and research directions. Their analysis was based on a search of relevant publications in Scopus and Web of Science. Osatuyi et al. [11] emphasized the increasing attention being paid to gamification in non-gaming contexts, especially in education. They advocated for organizing research and using common terminologies to promote progress in the field, offering a multi-method approach to review existing research in Information Systems education. Limantara et al. [3] highlights the importance of preparing graduates for the industrial world in light of technological advancements, particularly in the field of Information Systems. The study underscores the role of educators, especially at the undergraduate level, in retaining and enhancing students' interest in this discipline. The focus is on the application of gamification as a method to achieve this goal. It employs a systematic literature review methodology to identify key factors influencing the successful implementation of gamification in Information Systems Education at the undergraduate level. The factors identified include motivation, engagement, perceived utility, game design, and student perspective, all of which play a significant role in the effective use of gamification for learning in the context of Information Systems education. Figure 1 showcases the factors in gamification for information systems education, highlighting the importance of alignment with the learning objectives.

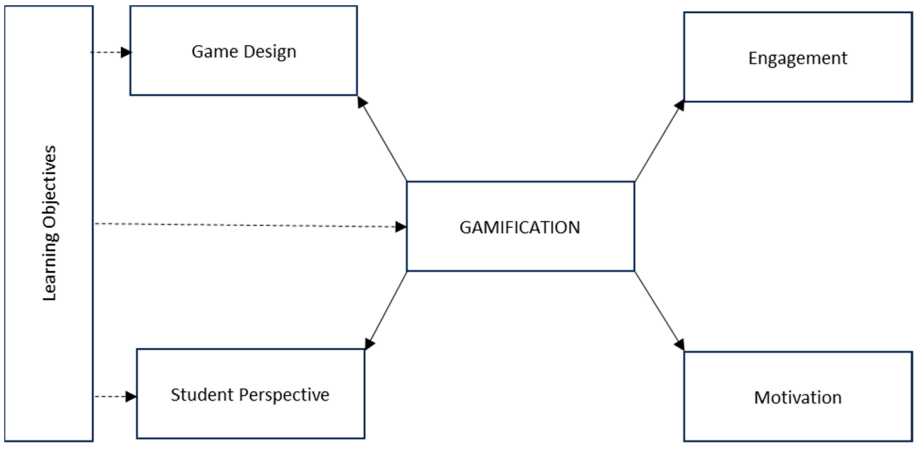

Figure 1. Factors of gamification for learning in IS education (adapted from Limantara et al. [3]).

Nevertheless, while gamification in Information Systems education offers significant advantages, it is not without its challenges. Challenges in this field include designing

gamified experiences that align with specific learning objectives and avoiding the risk of prioritizing entertainment over education. Striking the right balance between fun and meaningful learning can be a complex task. Additionally, evaluating the effectiveness of gamified content and its long-term impact on students' skills and knowledge remains a challenge in the context of seeking to attain the full potential of gamification in Information Systems education.

SCRUM

The use of SCRUM in software development dates to the early 2000s [12,13] and its application has been constantly growing since then, which makes it increasingly necessary to develop SCRUM competence in future professionals [8,13–15]. It is expected that around 80% of companies that currently develop software use agile methodologies, and mostly SCRUM [12]. SCRUM is a software development framework, framed within agile methodologies, where solutions/products are created using a set of iterations and evaluations, and through self-organized teams [16,17]. In SCRUM, products are progressively developed and improved in an iterative and incremental way, by a SCRUM team. In this team, members assume three roles: Scrum Master, Product Owner and Development Team. The work is done in small iterations, called sprints, with a pre-defined duration.

SCRUM encompasses two artefacts and four ceremonies or events. The two artefacts are the Product Backlog (contains the work that the Development Team has to do, described through user stories) and the Increment (the completed work that adds value to the customer, helping to achieve the objectives of the required system). The four ceremonies or events are Sprint Planning (the sprint objective is defined, users' stories are selected from Product Backlog by building the Sprint Backlog and defining a work plan to guarantee the delivery of the Increment), the Daily Scrum (short daily meeting, where the development team finds out what was done and reorganizes the work among the team), the Sprint Review (meeting where the work done is inspected and discussed, which will lead to an Increment), and the Sprint Retrospective (meeting where the way the work was done is examined and discussed and how to improve in the next sprint is identified) [16,17]. Figure 2 represents the sequence of steps, roles and ceremonies in SCRUM framework.

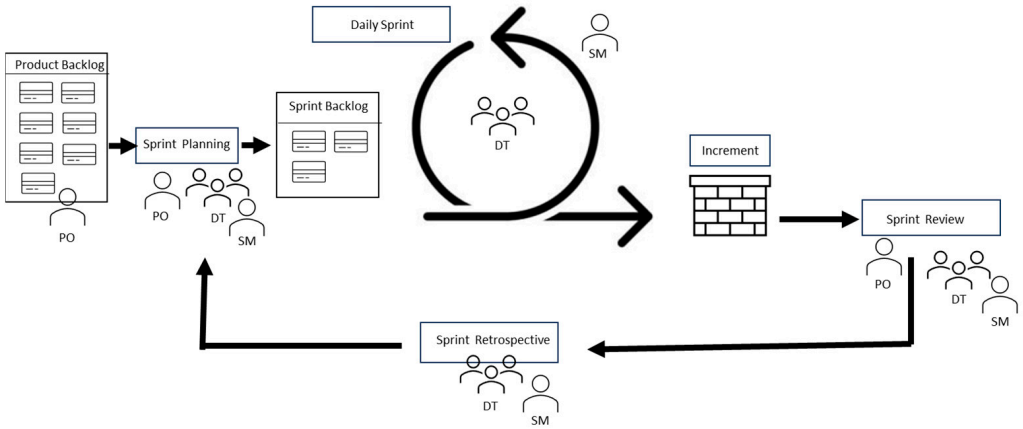

Figure 2. Illustration of Scrum framework.

One difficulty associated with learning SCRUM is making sure all participants clearly understand the roles and responsibilities of each member on the team [13–15]. A set of strategies are used to teach the SCRUM framework, and the most frequent is through project work. However, in this case, it cannot be applied to first-year students of this course in the same way as it is applied to other courses that use project approaches, since they do not yet know how to program, so they are therefore unable to build the product/increment. As it was not possible to use the project methodology with the students of this degree, there was always a need to search for an alternative method in order to overcome the difficulty of students understanding the roles and ceremonies of SCRUM. In this way,

gamification was seen as a way to contribute to student engagement in learning, as they are able to simulate its applicability using Lego bricks, which allows them to build a product/increments [9,17–19].

This paper aims to analyze a case study on the use of gamification to learn SCRUM. The gamification process was based on the use of Lego bricks [13], similar to the lego4scrum methodology, applied to explain the concepts related to SCRUM to students in the first year of their degree in Information Systems for Management. The objective of the study is to analyze student's understanding of the SCRUM approach.

When using lego4scrum as a gamified approach to learning SCRUM, specific characteristics of gamification are evident in how roles and ceremonies are structured and executed. Some of these characteristics include role-based engagement, goal orientation, feedback and progression, collaborative learning and real time management. Gamification encourages active participation by assigning students specific roles. Each role carries distinct responsibilities and objectives, fostering a sense of ownership and accountability. Like in gamified experiences, lego4scrum sets clear goals for participants to achieve during each sprint. For instance, the Development Team focuses on building increment within the timebox. These goals provide a sense of purpose and direction, driving engagement and focus. Continuous feedback and collaboration is a fundamental aspect of both gamification and SCRUM. In lego4scrum, students collaborate within their respective roles as a SCRUM Team to plan, execute, and review each sprint. This fosters teamwork, communication, and collective problem-solving skills, mirroring the cooperative dynamics often found in multiplayer games. By embodying these characteristics, lego4scrum transforms the learning process into an engaging and immersive experience, where students not only grasp the theoretical aspects of SCRUM but also internalize its principles through active participation and experiential learning.

2. Materials and Methods

As previously stated, this case study aims to verify: (1) how students understand the different roles of SCRUM and each ceremony; and (2) how students understand the structure of the SCRUM framework. An environment that simulates the SCRUM usage situation was created through gamification using Lego bricks.

A single case study was carried out allowing us to capture the experience of the participants and what these experiences meant, as argued by Yin [20]. The participants of this case were students in the 1st year of the degree in Information Systems for Management enrolled in the Information Systems curricular unit. One of the learning objectives of this curricular unit is: to recognize the relevance of the objectives and concepts of the SCRUM framework to information system development. Twelve students of this curricular unit voluntarily participated in this gamification session and three teams were formed.

We used the triangulation of quantitative and qualitative data, collected using different methods: first, direct observation of the teacher and students' written comments collected during the gamification process was used; secondly, we applied a survey to students who participated in the game; third, we performed analyses of students' grades in the written test. Direct observation and the collection of feedback from students were done during the single gamification session, according to the guidelines of the lego4scrum methodology [19].

The Process: Pre- and During-Game Activities

The activities carried out to design and implement this game, using Lego to teach SCRUM, were based on the lego4scrum methodology [19]. Table 1 represents these activities. The lego4crum methodology was developed by Alexey Krivitsky, the 1st edition being in 2009 and the last revision in 2023 (https://www.lego4scrum.com/, accessed on 20 December 2023). Based on this methodology, we structured our experience of using Lego bricks to teach SCRUM into 3 major activities: pre-game, in-game and post-game (Figure 3).

Table 1. Data collected in retrospective sprints.

Team	Sprint 1	Sprint 2	Sprint 3
1	Pay attention to detail	We divide the tasks among the development team elements during the Sprint	We forgot to carry out the Sprint Review at the end of the second sprint, having continued without approval of the increment by the Product Owner
2	We cannot build with the resources (Lego pieces) available	The sprint goal was poorly defined	Acceptance criteria were not met
3	There were doubts in the users' stories and consequently the increase did not meet expectations There was difficulty in managing the available materials (Lego pieces)	All acceptance criteria were met	Users' stories were misinterpreted

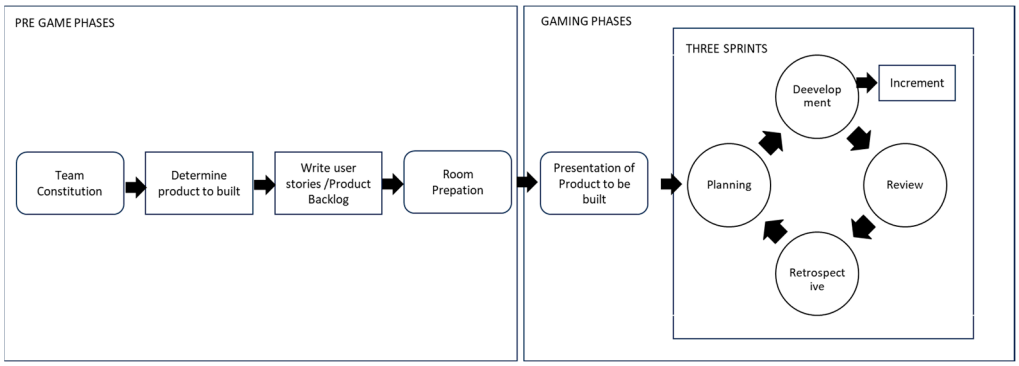

Figure 3. Activities included in Pre-Game Phases and Gaming Phases.

The pre-game activities, carried out by the teacher, were as follows: team formation, definition of the product to be built, writing of User stories for the Product Backlog construction, and room preparation. During the in-game activity, each team had to plan the Sprint (Sprint Planning), build the Increment, review the increment (Sprint Review) and hold the retrospective meeting (Sprint Retrospective). Each team completed three sprints during the game. The Daily Sprints were not simulated since each sprint had a goal and short duration.

In the previous class, the game objective had been explained to all students who participated: different roles of SCRUM, the objective of each event (ceremony), and the structure of this information systems development framework. Frames were provided, in the form of a review, about the SCRUM roles and ceremonies that would be applied in the game, describing each one: what it is, main objective, inputs, outputs and what leads to not carrying out the ceremony. On the game day, the rules of the game were explained to the 3 teams.

The teams were built, and the room was also prepared. The teams worked in groups and were placed in different areas of the room. Each team had access to a Lego box, a post-it and a kanban board. Figure 4 shows the prepared room.

Three teams were created, with four members each: three students taking on the role of Development Team and one student taking on the role of Scrum Master. The role of Product Owner was assumed by the teacher. All students had already taken classes on SCRUM and already had knowledge about the roles, the ceremonies as well as the artefacts, namely, the

Product Backlog, and about writing User Stories, the Sprint Backlog and the Increment. The students had previously practiced user stories in four classes of the curricular unit.

Figure 4. The prepared room: a team's work area.

The teams were formed by students, who voluntarily wanted to participate in this "game". Each team had a specific product to build: a classroom building for an educational institution, a student support services building for an educational institution, and a building for dining services and student associations for an educational institution. For each product, the Product Owner wrote the User Stories and specified the Acceptance Criteria, such as "the bathrooms must have access for people with reduced mobility".

On the day of the game, each team randomly selected the product to be built and defined the role that each team member would play in the game. The teacher provided each team with their respective User Stories and discussed them with each group in order to make sure that the product to be built was understood by everyone. The Master Scrum reproduced the User Stories on the post-it (on the back of the post-it the respective Acceptance Criteria were written) and began the construction of the Kanban framework. The teacher explained the rules of the game, reproducing the SCRUM philosophy, communicating the time each group had for the different ceremonies.

The teacher started the game with the first Sprint Planning. Each team, bearing in mind the product to be built, prioritized the User Stories and defined those to be developed in the first Sprint. They posted the post-it in the "To do" column of the kaban table. Figure 5 illustrates the kaban of one of the groups.

Students had 15 min to build each Increment, controlled by a timer. When the Development Team assumed that the Increment was finished, they called the teacher, assuming her role as Product Owner, to start the Sprint Review. In the Sprint Review, the Development Team and the Scrum Master showed the Product Owner how they satisfied all the User Stories and how the objective of the Increment had been achieved. In the Sprint Retrospective, each team met alone for 5 min, without the presence of the Product Owner—the teacher—having identified problems from the previous sprint and thought of ways to adjust their way of working in the next Sprint. The second Sprint Planning restarted with the presence of the Development Team, Scrum Master and Product Owner. The teams selected the User Stories that would give rise to the new Increment. They built the Increment in another 15-min Sprint. All teams completed the Sprint with the Sprint Review and the Sprint Retrospective. The same activities were performed for the third and the final Sprint.

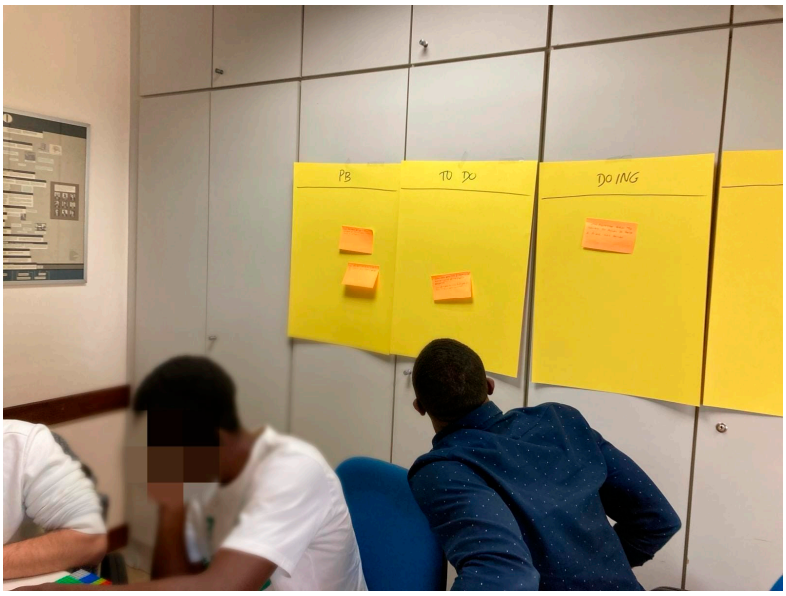

Figure 5. The use of the *Kanban* board during the game.

3. Data Collection and Results

In this case study, different types of data were collected.

In the Sprint Review, as the teacher had the opportunity to be present, she found that one group was unable to implement all the User Stories selected in the first Sprint (one remained unimplemented) and the other two Sprints did not meet all the objectives expected for the Increment. Another team did not reach the goals of the first Sprint but the Increment was approved in the next one. The other team did not meet all the Increment objectives; however, in the second Sprint, the Increment objective was approved, and it was not approved again in the third sprint.

During the Sprint Retrospective, each group wrote on a sheet provided by the teacher the main flaws that were identified in each of the Sprints. Table 1 summarizes the information collected.

One week after the gamification class, the students who participated were asked to respond to an online survey. The online survey had 15 questions: 14 closed and 1 final open-ended. The questions were organized in three major topics aiming to understand, respectively, how students understand the roles, the objectives of the ceremonies, as well as the structure of SCRUM. The survey was created on Google Forms using a Likert scale from 1 (did not contribute at all) to 5 (contributed a lot). The last open question aimed to understand the three main difficulties that students had in the SCRUM simulation process using gamification with Lego bricks.

The survey began by asking the student to identify which role he/she assumed in the game (Development Team or Scrum Master). Of the 12 students who participated, only 8 (66.6%) responded, of which 7 took on the role of Development Team and 1 the role of Scrum *Master*. The survey was elaborated using a Likert scale where 1 meant "did not contribute at all" and 5 meant "contributed a lot". Figure 6 summarizes the results obtained, relating to the three research questions. The figure shows the average response to each of the questions asked in the survey.

The survey had one more question, "Select the three main difficulties you had in the SCRUM simulation", which was answered by only one student who pointed out "Effective team collaboration and communication".

Figure 7 shows that 37.5% of students answered the question "Lego allowed us to understand the need for the different roles of SCRUM" with the classification of 5 (contributed a lot) and 62.5% answered with the classification of 4, totaling 100% of students.

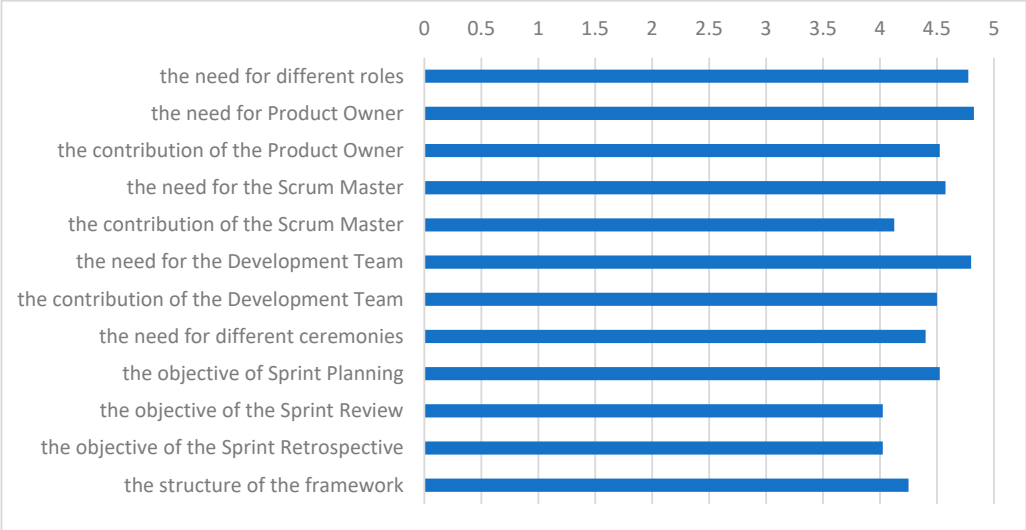

Figure 6. Data collected from the online survey.

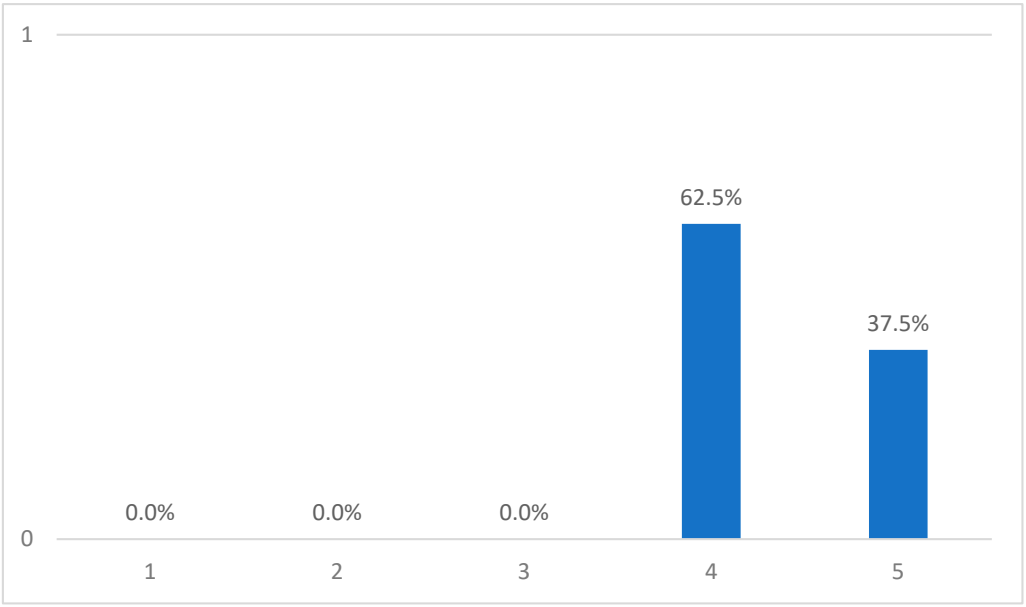

Figure 7. Answers: Lego allowed us to understand the need for the different roles of SCRUM.

However, regarding the question whether "Lego allowed us to understand the need for different ceremonies", 12.5% gave the classification of 2 on the Likert scale and 37.5% the classification of 5 as shown on Figure 8.

It should be noted that the student who responded to the survey and who had assumed the role of SCRUM Master assigned the maximum value (5) to all questions.

The written test was carried out in five classes after the gamification session and had a section including six multiple-answer questions about SCRUM, worth 6 points out of a total of 20 points. In this section of the written test, there were three questions about the roles and ceremonies, and this subset of questions was worth 3 out of the 6 points. The test was worth 20 points in total. Of the twelve students who participated in the game, eleven took the assessment test (one was absent for professional reasons).

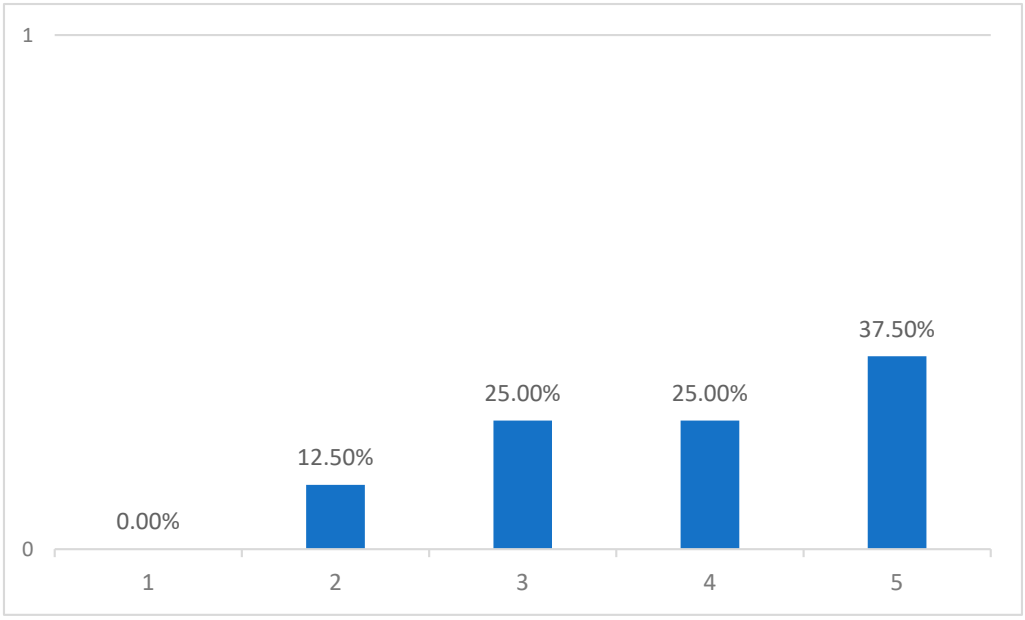

Figure 8. Answers: Lego allowed us to understand the need for different ceremonies.

The overall average grade for the class (17 students) in relation to the section of the test related to SCRUM was 4.52 points (out of twenty), and that for the students who participated in the gamification session and who took the test (11 of the 12) was 4.72 points. When analyzing only the three test questions on the SCRUM concepts developed with the game, the average grade for all students was 2.23 (out of 3 point) and the average for students who participated in the gamification was 2.63 points (eight students had 3 points, two students had 2 points and one student had 1 point). Table 2 summarizes these findings.

Table 2. Data collected in the written test.

Sample of Students	SCRUM Group (6 Points)	Subset of Questions about Roles and Ceremonies (3 Points)
All (17)	4.52 points	2.23 points
Who participated in gamification (11)	4.72 points	2.63 points
Remaining (6)	4.16 points	1.5 points

4. Discussion

The data collected through the online survey reveal that, in general, students felt that this gamification experience achieved its objectives. The students were able, in a positive way, to understand the SCRUM methodology through gamification using Lego bricks.

Analyzing the results of the test, we can see a much higher degree of success in the questions about SCRUM roles and ceremonies for students who participated in the game (2.63 points out of 3) than those who did not participate (1.5 points out of 3).

However, it should be noted that the students felt that the SCRUM roles were better perceived than the ceremonies. Despite the role of Product Owner being assumed by the teacher, the game contributes in a more positive way to the understanding of the needs and contributions of this member. The role of the Scrum Master was the one that was least well perceived via gamification. It was also felt, following the direct observation of the teams that, during the game, the Scrum Master assumed a greater role in the elaboration of the Increment than was expected, according to his role. However, it could also have been the low complexity of the product to be built that led to this lower understanding of the responsibilities of this role.

The flaws identified by the different teams in the Sprint Retrospective (Table 2) reveal and corroborate the lesser internalization of the need for ceremonies through the game. From the direct observation of the teams during the game, we can see that it was felt that the teams were very focused on the Sprint and on building the Increment, and less on the objectives and aspects to be reflected in the different ceremonies that precede and end the sprint, namely, in the following ceremonies: Sprint Planning and Sprint Review (one team even forgot to carry out a Sprint Review). Comments such as "We cannot build with the resources (Lego bricks) available", "Users stories were misinterpreted" and "The sprint objective was poorly defined" reveal that students undertook little planning for the Sprint before starting to build the Increments. The data collected from student in the Sprints Retrospective, such as "the sprint goal was poor defined", "there were doubts in the user stories", "acceptance criteria were not meet" or even "it was difficulty in managing the Lego bricks", reinforce the idea that the objective of the Sprint review was neglected by students, and leads also to a conclusion regarding why the game did not contribute in a more positive way to understanding the roles of each ceremony. It was felt that students, in general, were more focused on building the product, neglecting ceremonies and roles. This can be said because it was observed that (i) in some groups, the Scrum Master sometimes took on Development Team tasks, and that (ii) a team forgot to do one of the Sprint Reviews.

However, in general, the effects of using Lego in teaching SCRUM proved to be positive not only on the students' grades in the test, but also regarding their self-reflection on the learning carried out by the students in the survey applied. This gamification experience motivated students to be more engaged in the learning activities, enabling them to create the final product of each team (a classroom building for an educational institution, a student support services building for an educational institution, and a building for dining services and student associations for an educational institution) through several increments, according to the SCRUM methodology.

Although not all students voluntarily participated in the gamification experience, it is thought that, in the future, this could be different, since it was students' first experience with gamification, and because the students who participated, several times in subsequent classes, asked "When are we going to play with Legos again?". In this way, it can be said that gamification also contributed to the greater involvement of students in the teaching–learning process.

5. Conclusions and Future Work

This study, based on the use of gamification with the adaptation of the lego4scrum methodology, within Information Systems education, revealed interesting insights into its effectiveness and associated challenges, as reported in the literature review presented previously [6,10,11]. Students who engaged in the gamified learning environment demonstrated a better comprehension of SCRUM roles, scoring significantly better on assessments compared to their non-participating peers, as also demonstrated by recent research on the benefits of gamification in relation to achieving student learning outcomes [2]. However, it was possible to see a disparity in the assimilation of SCRUM ceremonies, indicating a tendency among students to prioritize product construction over ceremony adherence. This disparity was evident through observations and reflections on team behavior during the game, showcasing a lack of focus on planning and review ceremonies. Despite these challenges, students demonstrated improved self-reflection on their learning experiences, indicating positive perceptions of the gamification approach [3]. In class, after this experience, it was possible to notice the enthusiasm with which the students talked about gamification using Lego bricks.

Although this was a single case study, including only three teams of students, with a total of 12 participants, it was considered a positive experience for student's learning processes. Students were able to recognize the importance of this approach for their learning, and the findings from the student survey, teachers' observations and the written test confirm this. The challenge of creating an educational institution with Lego bricks

was considered adequate, as students were able to apply the SCRUM methodology and understand the different roles, the objectives of each ceremony, and the structure of the SCRUM framework.

This case study, designed and aligned with specific learning objectives of the curricular unit, was proven to be successful, and can be used to offer guidelines for future gamification implementations in Information System curricular units, as already suggested by Thongmak [4] and Limantara et al. [3].

In terms of future work, this methodology will continue to be used in the context of teaching SCRUM; however, an attempt will be made to increase the level of complexity of the game, with only one product to be built by the different teams. This change will bring the game closer to the reality of the software development process, also making itmore aligned with version 3 of the lego4scrum methodology approach, which is more aligned with the Nexus framework (https://www.scrum.org/resources/nexus-guide—accessed on 20 December 2023), where SCRUM is used to develop great software products and built by multiple teams. On the other hand, it will require greater integration between teams and consequently respond to the difficulty mentioned: collaboration and effective communication. Although it is not possible in this first year curricular unit, since the students do not yet know how to program, it will also be interesting, in future work, to compare the learning of raw materials through project work and gamification using Lego breaks.

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Institutional Review Board Statement: Ethical review and approval were waived for this study as it presented no more than minimal risk, there were no personal data involved and there were no clinically related outcomes associated.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to containing information that could compromise the privacy of research participants and the higher education institution where the study was developed.

Conflicts of Interest: The authors declare no conflicts of interest.

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