Game elements in a software engineering study group: a case study

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***Abstract*—This paper presents a case study of a gamified learning experience, designed with a guiding gamification framework, for a software engineering study group. The group was formed to evaluate the learning experience in a laboratory-like setting, and the results are intended to inform the design process. Grounded-theory procedures were used to analyze qualitative data about students' perceptions of the gamified experience. Students reported positive effects such as improved content comprehension, retention, and recap. They also highlighted a positive change in the study dynamics, especially due to the practical application of concepts, the game-like experience and a reduced amount of time for studying. The latter, however, was associated with a specific type of challenge proposed as part of the gamified structure. The other type of challenge, actually, made them face difficulties related to a lack of time. They also did not progress to higher levels of evolution proposed in the gamified structure. These are indicative of the need to improve the learning experience. These improvements, also discussed in this paper, will be evaluated in real settings in future work.**

***Keywords*-Software Engineering Education; Gamification; Grounded-Theory.**

I. Introduction

Currently, the majority of computing curricula has at least one software engineering (SE) course once it was recognized as an important discipline in computing practice. Since its conception as an education requirement for computing professionals, much has been discussed regarding what should be taught. In this direction, endeavors such as SWEBOK [1] and computing curricula projects [2] have made great contributions. These efforts are particularly important as SE instructors need guidance on what is the core, fundamental knowledge they have to work on in their classrooms, along with the knowledge about technologies that employers will require from their students [3].

From the perspective of SE as a discipline outside computer science, discussions on the level at which to keep university SE education, whether at the graduate or undergraduate level, have also been in the spotlight. In the last few decades, undergraduate SE programs have spread around the globe [4].

Nevertheless, focusing software engineering education discussions on what to teach and at which level is not enough. The SE community is also discussing how to deliver SE knowledge appropriately, avoiding situations where students realize its importance and applicability only after completion of their courses, i.e. when employed and in need of applying it. More often than we desire, however, computing course students are not sufficiently engaged in their learning process of SE concepts, methods and techniques. Many reasons may be presented for this lack of motivation, like the ones listed below:

- Some students are "naturally" hard to reach with traditional teaching methods. They may not pay attention to lectures, may not complete suggested exercises, or may not work so hard in group assignments, failing to adopt recognized study techniques (like the ones proposed by Dunlosky [5]) even when the teacher creates opportunities for them to do so;
- Some students do not understand the importance of SE for their future careers and, therefore, are not willing to put in greater effort to learn more about it;
- Initial courses in computing are mainly technical and focused on small, highly structured, and well-defined problems, which enable students to succeed without SE; however, this kind of success is not usual outside university settings [6]

In this scenario, an interesting question whether if there is anything SE course instructors can do to raise students' motivation and engagement, as well as awareness about SE importance and applicability. As Frailey commented, we are witnessing a widespread change in how education is delivered [3]. Lethbridge et al. pointed out that improved instructional tools are a future trend in SE education [4]. Therefore, it may be the moment to ride the wave of innovative methods of teaching as an alternative to deal with the above-mentioned problems in SE education. Gamification may be one (not so) new path to foster engagement of SE students. Given the dominant characteristics and needs of today's students, especially those of Generation Z, it was suggested that gamification should be considered an entirely new learning theory, side by side with the already established behaviorist, cognitivist, constructivist, and connectivist approaches [7].

In fact, gamification use in the classroom has already been the object of some investigation. Two systematic mappings testify to this. The first one, dated 2013, selected 26 primary studies. The authors of this mapping concluded that most research about gamification on education was published in conferences and focused on higher education. They also

discussed the objectives of primary studies, concluding that most of them concentrate on evaluating gamification experiences in raising students' engagement. Some important gaps highlighted are (a) the lack of validation research, which involves the proposal of novel techniques/methods and their evaluation in laboratory settings, before any evaluation in real settings with an improved version; (b) the need for more research that reports personal experiences with gamification in learning environments; and (c) the lack of approaches combining gamification and computer-supported collaborative learning [8].

Dicheva et al. investigated educational contexts to which gamification was applied as well as the game elements that were used. They selected 34 papers for analysis. After separating game elements in game design principles and game mechanics, they classified papers accordingly. The most widely used game design principles by the studies were visual status, social engagement, freedom of choice, freedom to fail, and rapid feedback. They discussed that some game design principles are naturally educational ones as well and, therefore, are not explicitly explored in the analyzed primary studies. As for game mechanics, the most popular are points, badges, and leaderboards, a "combo" that is known in gamification as pointsification, which has been the object of criticism [9]. Most of the studies reported are about gamification of blended courses on higher education and training level and on computer science or information technology courses. There is also a broad spectrum of implemented support for gamification, ranging from complete automated support to the use of no platform at all. The results of primary studies were also found to be mostly positive, although there are some mixed results reported as well. Researchers described the following gaps: (a) the need for more true empirical research about the effectiveness of specific game elements in learning environments; (b) and the need for demonstrating in practice the effect of emerging configurations of game mechanics and game design principles on learning [10].

Therefore, as a contribution toward filling in the gap in validation research, this paper presents a gamified learning experience and its application in an SE study group, composed of voluntary students from three SE courses - our "laboratory setting". We also present our own lessons learned and points of view about this endeavor, as a contribution to fill in the gap of the need for experience reports as well. Following the categories presented by Borges et al. for classifying research objectives related to gamification in education, as in [8], we position our study as focused on both student engagement and improved learning. We also claim that our gamified learning experience provides, in practice, demonstration of game elements and its qualitative evaluation [10]. We also believe this study can help raise the level of educational research in SE, one of the challenges posited by Lethbridge et al. when discussing how software practice could be improved through education [4].

In this paper, Section II presents further clarification about gamification, its history, and a couple of grounding gamification frameworks. Section III presents the study methodology. Section IV describes the application of gamification to the design of a learning experience for an SE study group. Section V provides the results observed in students' evaluation scores and engagement perceptions. Section VI introduces a debate about the results, especially about implications for practice and future research. Finally, Section VII presents the concluding remarks.

II. Gamification

All around the globe, people of all ages play. They play with toys, they play games, and this ultimately influences the activities they perform in their daily lives. Although similar concepts, play and game are pretty distinct. Play is more about self-satisfaction, allowing for freedom of action and exploration of boundaries. Games are more about submitting yourself to a set of external rules, in pursuit of predefined goals [11].

As Deterding et al. states, gamification is about games, not about play [12]. The term was first used in its modern sense in 2003 by British researcher and game developer Nick Pelling in consultancy work related to gaming interfaces for electronic devices [13]. Kevin Werbach and Dan Hunter claim that the term gamification fell into disuse, and was subsequently used again by known game designers like Amy Joe King, Nicole Lazzaro, Jane McGonigal and Ben Sawyer. In 2010, gamification was "the new hot business concept" in business magazines and meetings [14]. In this context, gamification stands out as a mechanism to solve problems and leverage large enterprise projects [15]. Although much has been discussed about gamification, as in [16], [17], we cite Deterding et al.'s definition: "Gamification is the use of game design elements in non-game contexts".

Game design elements are, therefore, an essential part of the gamification toolkit. In this sense, Werbach and Hunter provide a pyramid of game elements that can be used to help the design of gamified systems [14]. Their pyramid model is inspired on the MDA (Mechanics, Dynamics, and Aesthetics) framework, a formal approach that has been used to understand, design, and criticize games [18].

A. Pyramid of Game Elements

An illustration of the pyramid of game elements is shown in Figure 1. The higher level layer in the pyramid is the dynamics one. It is related to the creation of experiences that motivate users to keep playing. They are the big-picture aspects and encompass elements such as restriction, progression, emotion, narrative and relationships.

The mechanics layer refers to elements that foster user engagement, processes that drive actions forward, providing ways of achieving one or more of the dynamics elements. For instance, feedback and rewards (mechanics) can give a sense of progression (dynamics). Depending on the mechanics used, games may have a wide variety of styles (action, sports, strategy). Some types of mechanics elements include challenges, feedback, cooperation and rewards, among others.

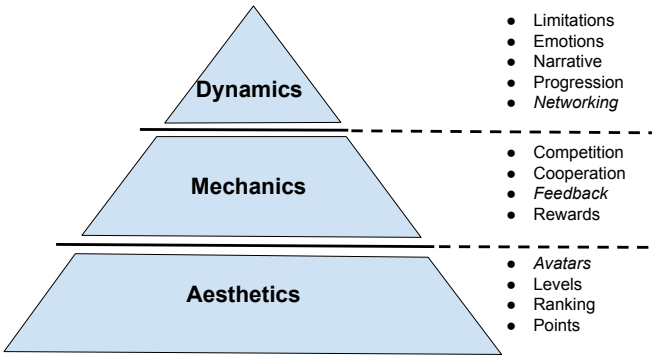

Fig. 1. Pyramid of game elements - Adapted from [14].

The layer at the lower level of abstraction, and therefore the one that is closer to the users, is the components one. It encompasses elements such as avatars (visual representations of a character or team), boss fights (huge obstacles, which lead to a level transition), collections, quests, badges, and points, among others. Each component can be tied back to one or more of the game's mechanics and dynamics. For instance, badges and points (components) are implementations of rewards (a mechanic) that can aid in progression (a dynamic).

B. Gamification Design Framework

Frameworks and methods to aid the design process are needed to get to motivating gamified experiences such as the Gamification Design Framework (GDF) [14] and the method proposed by Morschheuser et al. [19]. In this section, we present an overview of the GDF, adapted from [14]. This framework is composed of the following six steps that aim at leading the identification of the objectives to be achieved with the gamified system and at assisting designers to put game design into practice:

1) Define business objectives: state why to gamify, the benefits to be obtained, and specific goals. Describe the positive results expected with the gamified system;
2) Delineate target behaviors: state what is desired from players, as well as metrics of the desired behaviors;
3) Describe your players: describe who are the players and how are they related to the gamified systems designers. Use demographics, psychographics, or even player typologies;
4) Devise your activity loops: describe how players will be motivated by the system, considering engagement and progression loops as well as the feedback system. Describe how players will progress in the system, including considerations about onboarding and scaffolding;
5) Don't forget the fun: explain how to include fun elements in the gamified system. Highlight which aspects would be motivating, even if there were no rewards to be earned;
6) Deploy the appropriate tools: explain how the system will look, identifying specific game elements to be used. Describe the target platform over which the system will be run. Tie back these decisions to the ones taken in previous steps.

III. Study Methodology

As a starting point for our research about gamification in education, the following research questions were proposed:

- Do game elements and game design enhance the learning experience and engagement for studying SE concepts, methods and techniques? If they do, which improvements are perceived by students?
- Do game elements and game design improve students' performance in SE courses?

No hypothesis was devised in association with the research questions proposed. In this case study, it was expected that qualitative data gathered from interviews would provide insights on the first research question, and researchers had no clear expectations about specific game elements effects on students' perception of the experience, although researchers had expectations that positive overall effects would come from it. As for the second research question, it should ideally be addressed by an experimental design, from our point of view. This case study design, however, allows for a slight exploration of the second question.

A. Gamified Experience Design

A gamified learning experience was designed to answer the research questions. A first step was to identify game elements and game design techniques that could be used to propose a different teaching/learning dynamics. Two Coursera courses related to games - Gamification [20] and Understanding Video Games [21] - were the sources to define the Pyramid of Game Elements and the GDF as guides to designing the gamified experience.

Considering the GDF, it is important to "Define business objectives". The stated objectives of the gamified system, which are closely related to the research questions, were:

- Engage students in the learning process by increasing their participation rates in outside classroom activities;
- Improve students' performance in class evaluations (two written exams and one capstone project).

The next item in the GDF is to "Define target behaviors". In our case, the desired behavior was getting students to complete outside classroom exercises and software projects. Another item from the GDF is "Describe your players". Our public was composed of students from multiple computing undergraduate programs (computer science, computer engineering, information systems, software and development analysis) enrolled in three different SE courses. Most of them had no previous SE experience, and it was their first SE class. Most of them were male, young, had no job and no children.

The items "Devise your activity loops", "Don't forget the fun", and "Deploy the appropriate tools" are better explained in Section IV.

B. Study Group Formation

There were 131 students enrolled in SE classes in the first semester of 2015. These students were invited to join an SE study group, where the gamified learning experience was to be applied, even though students were not aware of this detail when they were asked to participate. To encourage students to take part in the group's activities, they were offered the option of exchanging points acquired in the group for scores in their final optional exam[1].

Thirty students decided to take part in the group's activities, which are detailed in Section IV. Therefore, the research sample consisted of volunteers, which poses some threat to the validity of the study (discussed in Section VII).

C. Data Collection and Analysis

As the group activities were executed, data about student's performance, engagement and perceptions about learning with the gamified experience were collected. Their performance was obtained from the university courses management system and measured by their grades in two written exams and a capstone project. Data about their engagement were collected mainly from completion of activities, measured by how many points they obtained as well as their evolution level. Some of these activities were executed during the group's meetings, whereas others were executed with the support of Moodle (a learning platform) [22]. The points earned as well as attendance at the group's meetings were recorded.

Data about engagement and students' perceptions about the gamified system were also collected through interviews. The interviews were partially structured and took place right after the third meeting of the study group by monitors of the class, even though they were less experienced as interviewers than the professor of the course. This design was deemed suitable so that students could be open about their points of view, considering the professor was responsible for grading evaluation exams. Guiding questions for the interviews were about (a) what motivated them most in taking part and continuing at the study group, (b) their willingness to participate in another group like this one (especially if there was no possibility of exchanging points obtained within the group for scores in the SE course), (c) their frequency of execution of activities outside the group's meetings and (d) which part of the group's structure they believed would be better to replicate during a formal SE course, like the one they were taking.

Data collected through the interviews were analyzed using grounded-theory guidelines, as recommended in [23], with the aid of RQDA (an R package for qualitative data analysis) [24]. The objective, however, was not exactly to build a theory. Instead, the focus was on obtaining insights on students' perceptions of their learning process with the gamified learning experience. Open and axial codings were conducted, and a final central story was built. Theoretical propositions were also identified and can be better explored in further research projects.

[1]The grade obtained in the final optional exam may substitute any of the grades of other evaluation exams if it is greater than one of them.

IV. Gamified Experience

In this section, details of the designed gamified experience are discussed. In this description, game components, mechanics and dynamics are cited in bold letters to make their identification clearer.

To tie all the pieces of the gamified experience together, a **narrative** was created, and its text is presented in Table I. An introductory video was edited to contain it. The video was presented during the first meeting of the group and was made available to all students in the group via Moodle.

TABLE I
Narrative text

Welcome to the SE Study Group! In Software Engineering, a group of engineers build software. But it is not any kind of software. It is all about big, complex, and critical products. That is what we want to learn to do! Therefore, we are focusing on how to gather a good team; how to help them to work well together; to build reliable and valuable software products. Let's start with the "how to gather a good team" item. Get together with your preferred colleagues. If you don't know your colleagues, guess what... Anywhere you'll work, that will probably happen as well! That is your team, until the end, no matter what! They will help you in your journey to becoming a better software engineer! Because you are already a software engineer (you build software, don't you?) But there is a lot to be learned still and that is why you are a junior software engineer [At this point of the video, the badge for junior software engineer level is presented on the video]. The next step is to become a full software engineer [At this point of the video, the badge for full software engineer level is presented on the video]. To, finally, become a senior software engineer [At this point of the video, the badge for senior software engineer level is presented on the video]! To accomplish that, we are going to have some meetings with some activities (quizzes and quests), which can give you experience points (XP), to help you to progress through the different SE levels. There is also a web page with other activities! They'll give you extra XP! Take a look at Moodle homepage: Software Engineering Study Group Gather your team, and get to work!

Another important dynamic to the designed gamified experience was **progression**. As noted from Table I, students were led to evolve through SE **levels** - from Junior SE I, Junior SE II, through Full SE I, Full SE II, and to Senior SE - which are described in Table II. Each level achieved was granted a **badge**, as illustrated in Figure 2, as one of our concrete implementations of the **reward** mechanics. All students started at the Junior SE I **level** and had the corresponding **badge**. To go from one **level** to another, they had to earn the required **experience points (XP)**, that were also part of our **reward** system. Depending on the **level** desired, they also had to complete a **quest** with a specific difficulty level - a kind of a **boss fight**.

TABLE II
Levels and their requirements

Level	Requirement
Junior SE I	0 XP
Junior SE II	250 XP
Full SE I	250 XP and a medium difficulty quest completed
Full SE II	800 XP
Senior SE	1100 XP and a high difficulty quest completed

Another element of **progression** that was added to the experience were the **progress bars**. Note that they are not a component in the Pyramid of Game Elements, described in Section II. They are, however, an important element of our experience design.

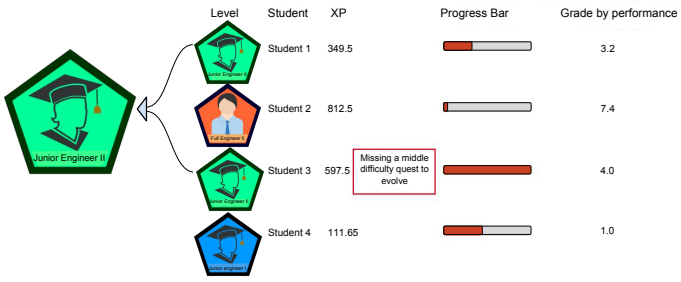

Fig. 2. Level progression

It should be highlighted that Figure 2 does not present a **leaderboard**, even though that is a commonly used component in gamification, once we did not order students based on how much **experience points** they had or at which **level** they were. We decided to use a lexicographical order to present their performance instead, as it has been suggested that leaderboards may foster destructive **competition** [25], and be demotivating, especially for those at the bottom positions.

Students were enabled to complete **achievements** by overcoming **challenges** in the form of quizzes and **quests**, thereby acquiring **XP** for them. Quizzes were individual **challenges**, structured as questions and answers. No difficulty level was assigned to them, and each was worth 50 XP. **Quests** were supposed to be completed by **teams**, as a way of fostering **cooperation**, and were described as software projects to be partially or fully completed. Some of the quests had prerequisites. They could be started only if another quest had been successfully completed; that was our way of implementing **content unlocking**. **Quests** also had different difficulty levels, depending on the deliverables demanded for completing them, and they were considered completed if 75% of their **points** were earned. Table III presents **quests** difficulty levels and **XP** that could be earned at each of them. It also presents an excerpt of the description of an exemplary medium difficulty **quest**. Its completion would unlock another **quest** - related to the design and coding of the corresponding system.

One of the game mechanics we built into our gamified experience was **feedback**. It was automatic for quizzes. The calculation of **XP** attributed for quizzes completion, on the other hand, was manual. For instance, if a student got 80% correct answers for a quiz, he/she would get 40 XP (80% of the **points**). For **quests** both the **feedback** and the calculation of **points** were manual. Table IV presents the feedback report given to a team for the **quest** briefly described in Table III.

It should be noted that the **feedback** report for **quests** was designed to encourage new submissions, pointing out their mistakes so that they correct them and try again. They were allowed to try up to three times. They also had the chance to retry and answer quizzes as well, up to three times. However, quizzes had a deadline. **Quests** could be submitted at any stage from the beginning of the semester, till around 15 days before its end.

[2]200 XP was the total points that would be given for a completely correct quest, according to Table III.

[3]This was the second feedback report given to this team.

TABLE III
QUESTS LEVELS AND AN EXCERPT

Quest Difficulty Level	**XP**
Easy	100 XP
Medium	200 XP
Hard	300 XP
Extremely hard	500 XP

Excerpt of the description of an exemplary quest

Name: SRS and Prototype for the DisDisc System

"**Scope:** The Discipline Distribution System (DisDisc), shall: (...) (3) Allow any professor to choose the weights to the disciplines he is interested in, during the time set by the Distribution Committee for doing so, enabling them to point out what are their preferences. (...)

Deliverables: "(1) Software Requirements Specification: Shall contain the product's requirements. If there are functional and nonfunctional requirements, they should be separated in different sections;

(2) Prototype: Paper, video or functional prototype, or digital mockup - presenting screens and their interaction."

TABLE IV
FEEDBACK REPORT FOR A QUEST

"Your final XP for this quest was composed as described bellow:

- Correction percentage for SRS (CSRS): 60%;
- Correction percentage for Prototype (CP): 100%;
- Final correction percentage ((CSRS+CP)/2): 80%;
- Total XP earned (200*0.8): 160 XP[2];

For the quest to be considered concluded, the final correction percentage should be higher than 75%. Congratulations! You have concluded it!

Comments on the SRS:

- Requirements regarding authentication are not free of implementation details, as recommended;
- Requirements still[3] are not uniquely identified, as recommended, making it difficult to reference them.

There were also additional problems to recently added requirements:

- The requirement *The System shall allow the professor to determine initial and finish dates to each discipline (...)* should not exist. It is not a requirement for this system.
- The requirement *The System shall manage the discipline distribution each year* is vague. What does manage mean in this case?"

The GDF requires gamification designers to "devise your activity loops", as part of the gamified systems design. **Challenges** providing **experience points** were the elements used to allow students to progress, in our gamified learning experience, and therefore, **achievements** were designed to attend to this item. The narrative along with the levels, points, and badges, were designed to add a fun element to the learning experience, as the item "Don't forget the fun" in GDF suggests. Finally, the item "Deploy the appropriate tools" requires the definition of the specific game components (if they were not identified yet in other GDF items), and the **feedback** element was added

to enrich the experience.

V. Results

Both quantitative and qualitative data were collected to analyze students' performance and perceptions. However, (a) the lack of random assignment to the study group, (b) the small and voluntary sample of students in the study group, and (c) the fact that students who were not part of the group do not form a comparison/control group are all acceptable reasons to keep the quantitative data only for exploratory sake. They were not used, therefore, in statistical tests of any hypothesis, as this was meant to be done in subsequent research projects, with an improved design for the gamified experience, as informed by these case study results.

A. Students' Performance

As part of the course evaluation system, there were two written exams and one capstone project. Together, they determined students' final grades for everyone enrolled in one of the three courses in the first semester of 2015. Each of these activities could be scored from zero to ten. To pass, students needed an attendance rate of at least 75%[4] and a final grade greater than six. Table V presents data regarding the number of students who passed and failed the course.

TABLE V
Enrollment and participation in the SE Group

Situation	SE Group	Not in SE Group	Total
Students who passed	21	50	71
Failed due to attendance	3	37	40
Failed due to grade	6	14	20
Total	30	101	131

The 40 students who failed for not satisfying the 75% attendance rate, of which three were participating in the SE study group, did not complete the evaluated tasks (exams and capstone project). Therefore, their performance data were not included for performance analysis, once their scores were zero.

As can be seen from Figure 3, students in the group got better overall scores compared with students who were not in the group.

Considering only students who passed the courses, the performance is slightly better for students in the SE group. Their median is one point higher compared with that of students who were not in the group.

B. Students' Evolution in the SE Group

In this section, students' evolution in the SE group and the amount of XP they obtained are examined. Figure 4 illustrates the distribution of XP earned by students. Most students got 500-600 XP.

Table VI presents more details about the distribution of XP that students obtained for each of the proposed activities in our gamified experience. It shows that the mean of XP of the group was 511.8, and this is lower than the amount of XP needed to go from Junior SE II to Full SE I.

[4]SE courses have 68 hours of classes in total, and students should attend to 51 of these, to satisfy the 75% rate requirement.

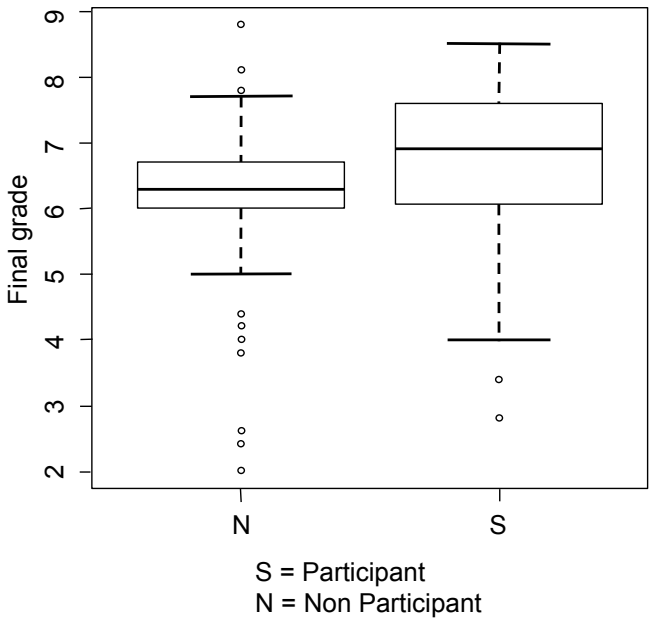

Fig. 3. Final grade comparison

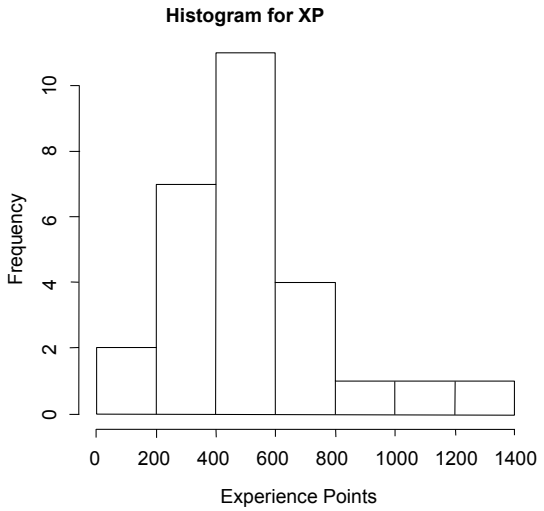

Fig. 4. Distribution of experience points

TABLE VI
Summary of XP obtained from the activities of the group

Activity	Min.	1st Qu.	Median	Mean	3rd Qu.	Max
Quests	0	0	0	92.85	66	750
Quizzes	11.1	157.65	197.5	195.4	250	350
Meetings	0	197.7	247.5	223.6	287.5	347.5
Total XP	25	352.8	473.5	511.8	613.2	1215

As shown by Figure 5, 60% of the students were at Junior SE II Level at the end of the study group. The fact that

most students did not engage in quests explains why most of them did not advance to higher levels, as it was a necessary condition to go to Full SE levels, and was also a way to get greater amounts of XP. It is evident from this that there was a problem in our design, regarding quests, and the results of interviews gave insights ON this.

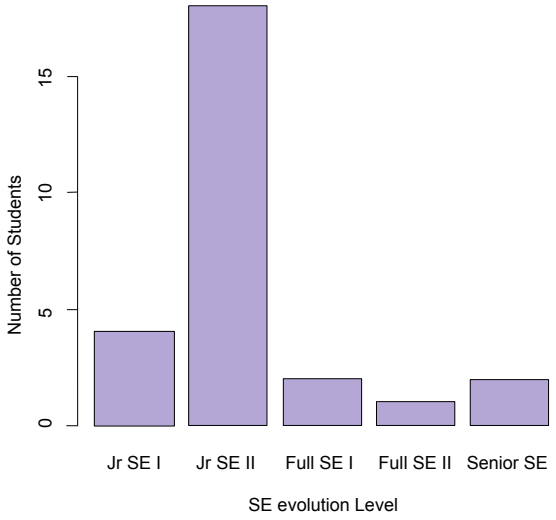

Fig. 5. Levels distribution

Excluding students who failed the course due to attendance, one student who kept the Junior SE I level failed, out of four. Five students who got Junior SE II level also failed, out of 18. Only five students got Full SE I or a higher level, and none of them failed.

C. Interview results: codes and categories

From interviews, open coding was the first step taken to understand students perceptions about the gamified experience. We constantly compared codes identified during an interview with previous ones from other interviews. This constant comparison was the main analytic tool used to identify the core categories that would better explain how students perceived activities and their feelings toward the gamified experience. Core categories are presented in bold letters, and codes are presented in italic letters.

According to students' perceptions, the gamified experience had a number of **positive effects**. The most cited changes were *aid in the study process*, *improved content comprehension*, *improved content retention*, and *improved content recap*. To a lesser extent, changes included *aid to evaluate their own knowledge*, *aid to keep the study pace*, and *improved knowledge gaining*.

Another positive effect reported was a **change in the study dynamics**. This effect was raised to the category level, as it has many facets depicted in students' interviews. The most cited changes in dynamics were *practical application of concepts*, *reduced amount of time for studying* and *game-like experience*. Students also highlighted changes like *higher interactivity levels*, *activities are cool*, *higher objectivity*, *participation of motivated students*, *friendly environment to asking questions* and *higher dynamism*. The *participation of motivated students* was a specificity of the group, and cannot be imputed to the gamified experience. Students also suggested that a *higher activities variety*, beyond *quizzes* and *quests* (**gamified structure**), would further improve their experience.

Many elements of the **gamified structure** also emerged from students' interviews. They commented on the *quizzes*, *quests*, *points*, *game-like experience* (shared with the **change in the study dynamics** category) and, to a lesser extent, on *team work*, *levels*, *well-defined objectives*, *challenges*, and *competition*.

Finally, students also commented on the **difficulties** with the gamified experience: *lack of time*, *other high priority activities*, and *the schedule of activities*. The reported *lack of time* was associated with *quests* (**gamified structure**) once they considered that *quizzes* (**gamified structure**) promoted a *reduced amount of time for studying* (**change in the study dynamics**). The difficulty regarding the *schedule of activities* cannot be related to the gamified experience per se. It was more because the face-to-face meetings were held during Saturday mornings, and classes are not usually scheduled for this period. Therefore, students who live in surrounding cities or who are not used to waking up early to attend classes found it difficult to take part in the group's activities.

From the codes and categories, a central story was proposed to represent students' perception of the gamified experience, as presented in Table VII.

TABLE VII
CENTRAL STORY

The **gamified structure**, in the form of gamified elements like *quizzes*, *quests* and others, formed the basis for the design of the gamified experience. This experience promoted a series of perceived **positive effects**, especially those related to *aid the study process*, as well as *content understanding, retention, and recap*, possibly due to a perceived **change in the study dynamics**. This change was noticed in the form of *practical application of concepts*, *reduced amount of time for studying*, and *game-like experience*. This change however, did not allow students to get rid of some traditional **difficulties** in their learning processes, notably the *lack of time* and *other high-priority activities*[5].

Theoretical propositions were also composed to better depict the relationships of codes and categories in this case so as to provide issues to be investigated in further research (in other scenarios). They are described in Table VIII.

VI. Discussion, Limitations and Future Research

From our experience with the gamified learning experience we have designed, some lessons were learned. First of all, a narrative based on students' evolution as software engineers may be really interesting, as this is expected from them, even though students in our case have not explicitly perceived this. The hero's journey may guide the development of such narratives [26], which should present them with a "call to

[5] *Schedule of activities* was not included, once it was related to a specificity of the group, not of the gamified experience

TABLE VIII
THEORETICAL PROPOSITIONS

Proposition 1: *Quizzes* are a motivating activity, as they aid in an *improved content understanding*, an *improved content recap*, an *aid to keep the study pace* and in a *reduced amount of time for studying*, once *lack of time* is an issue for many students.
Proposition 2: *Quests* are a motivating activity, as they aid in the *practical application of concepts*, but they require a lot of time and effort to be completed, and *lack of time* is an issue for many students.
Proposition 3: The distribution of *points* for activities (*quests* and *quizzes*) should be carefully done, avoiding situations where an equal number of points is awarded to them. The occurrence of situations like this was pointed out as a reason for students not attempting *quests* (as they would get the same amount of points from a *quiz*, which as easier and took less time). This situation was considered as unfair and demotivating by them, especially for those who completed *quests*.
Proposition 4: A *higher activities variety*, beyond *quests*, and *quizzes* may be needed to deal with the *lack of time* issue and to reach a greater number of students.

adventure", possibilities of "supernatural aid" and promote "the crossing of the first threshold".

Another observation is that experience points should be fairly distributed among activities according to their difficulties, when a points system is used. In our gamified experience, for instance, students reported that quizzes were a lot easier to complete than quests, but the points did not reflect this.

We would also advise that instructors be careful with freedom to fail for activities such as quizzes, as students may take notes on the correct answers and repeat quizzes with the only intention of getting points. If this behavior harms learning, do-overs should be penalized somehow. However, freedom to fail is an interesting game design principle to apply for quests, as they are complex. The quest feedback system should be designed to promote new attempts, pointing out specific mistakes to be avoided in subsequent project submissions.

Time availability is another important issue for students, as there are several exercises and projects to complete; however, students don't have to complete all of them to get all the points they need. Time availability is an issue for teachers as well, as a lot of time is needed to correct exercises and projects and to give immediate feedback, as has already been mentioned in previous studies [27]. For the teacher, lack of technological support is a major obstacle according to Dicheva et al. [10]. Automated quizzes correction is a necessity, and we were able to get it from Moodle. That was possible because we avoided open questions in quizzes at all costs. Nevertheless, we believe this may have caused the loss of learning opportunities for students. Automated quests correction, on the other hand, is highly desirable but seems difficult to attain. It should be noted that these are problems of traditional course formats as well.

A. Limitations

One of the limitations of this work was that students who took part in the study did it as volunteers. Therefore, some questions remain unanswered. Were the students in the group more naturally motivated to learning? Was their better performance related to a higher number of learning/studying opportunities provided by the group? How representative were they of regular computing students who attend to SE classes?

Another major limitation to our understanding of this experience was that we had only one round of interviews, and this is not enough to obtain theoretical saturation, as required for theoretical generalization according to grounded-theory procedures [23]. Therefore, there are some open questions to investigate. In a late analysis of our interviews, we realized that we did not explore much of students' difficulties and of what was not interesting in the gamified experience.

B. Future Work

One question for further inquiry is related to how to engage different kinds of players/learners [27]. From our experience, it is clear that different kinds of students may benefit from different kinds of elements. Hence, what are the particular game elements that are more appealing to distinct types of learners [10]? Identifying relevant player types may help in this endeavor, although applying existing player typologies from game design, like the famous Bartle one (which was extended in [26]) to gamification has been criticized [28].

Tondello et al. have researched on user types, rather than player types, specific for gamification, as well as user preferences toward game elements [29]. Therefore, their study is an excellent starting point for further investigation, as their results still need some improvement and their sample was limited to one university. Another important point is that they claim their typology applies to any gamification context. Nevertheless, as there is the question of whether existing player typologies are relevant across different game genres [30], we may also ask ourselves whether gamification user types differ across gamification domains. Therefore, research on gamification user types unique to the education field may be worthy. It may lead to better designed gamified learning experiences, satisfying different kinds of students, the same way that game designers/developers use player typologies to personalize a to game [29]. Barata et al. have already taken a step in this investigation, but their typology was constructed based on performance (experience points acquisition patterns over time) rather than on motivation [31], as usually has been the case for player typologies research. They do not justify this change, and we believe that the motivation-based approach may be more fruitful in aiding the design of gamified experiences that are appealing to a wider range of students. Their approach seems to be characterizing students' preference towards the game elements the researchers used in their experience design, and only those.

Another question is how to make gamification optional in educational settings for those who simply do not want to engage with it. The objective would be to avoid the gamified experience being considered an imposition to already motivated students, as Hannus and Fox say this can be demotivating [25]. As they discuss, gamification is more effective if it is not mandatory.

Although some authors have proposed the study of game elements in isolation, for the purpose of identifying the ones

more suitable to gamified experiences in education [25], [10], we can not envision how this can be done. As Werbach discusses, the elements are not the game. A successful gamified system comes from how the elements are tied together [20]. Therefore, the whole experience should be the focus of design and evaluation, instead.

For our future research, we plan on executing a case study in a course as a way of evaluating an improved version of the design of the gamified experience in a real setting - as opposed to a more laboratory-like setting, like the one we set in this case study. The improvements we plan to deploy in the gamified experience are given below (game elements and game design principles related to each item are emphasized):

- Make the gamified system optional. To promote its use, we plan to make it possible to exchange the **experience points** obtained with the gamified system for evaluation scores, but this is not a mandatory aspect of the course. Traditional exams shall be preserved for those not interested;
- Create a **virtual currency**, earned as **rewards** for **quizzes** and **quests** completed as well as for helping other students in forums. It could be used to buy tips for exams or capstone projects[6], to obtain quiz do-over opportunities with no penalties, and to extend the due dates of capstone projects and assignments, as proposed in [32], [33] apud [10].
- Make **virtual goods** available, possibly in the form of reliable documentation templates to be used in capstone projects. They could also be bought with the money students earn, or exchanged among students (**gifting**).
- Create **badges** for topic-related **achievements** in addition to badges for **levels**. We believe this can be an extra reward level.
- Breakdown **quests** into smaller pieces of work to make the path to their conclusion softer (**scaffolding**). This may increase participation.
- Reward posts and replies in forums, fostering **collaboration** that goes beyond teams.
- Redistribute **experience points** among **quizzes** and **quests**. Add **quizzes** with different difficulty levels, as has been done with **quests**. Give more **experience points** for **quests** in comparison to **quizzes**.
- Add a **chance** element. Simulate risks happening, as some serious games in software project management do [34], [35].

Another future step to be taken, after the case study in a real classroom one, is the design and execution of an experiment (or quasi-experiment) to compare results with the gamified learning experience and the traditional one. We envision some obstacles or threats to this endeavor. First of all, two risks for validity stand out: compensatory rivalry and resentful demoralization [36], if students get to know about differences in their class formats.

[6]Exams also grant evaluation scores, as well as capstone projects. They are usually part of the evaluation system of the SE traditional course format

Second, there is no possibility of random assignment of students to experimental and control groups, as students choose their courses during enrollment. Considering this, we are still wondering if it is interesting to keep the study group format to run a randomized experiment. In this case, it would not be a "real setting", and we believe we may not get representative students or a sample with an appropriate size.

VII. Concluding Remarks

This paper presents a case study reporting a gamified learning experience in a SE study group, formed with 30 volunteer students from three SE classes of the 2015 first semester. We used a guiding framework to design our gamified experience, as Domnguez et al. report this as one of the steps they will take in their future work [27].

Students in the study group got better overall scores and higher attendance rates in their classes compared with students who did not participate. However, they did not advance to the proposed levels as most of them did not fulfill one of the requirements: completing a quest. This can be indicative of the need for a wider variety of activities in the gamified experience to reach different kinds of students.

We also collected qualitative data about the experience, by interviewing students and analyzing data with grounded-theory procedures. Students reported a positive change in their study dynamics. The most commented-on changes were the reduced amount of time for studying, the practical application of concepts studied, and the game-like experience. It is interesting to note that the reduced amount of time to study stands only for activities in the form of quizzes. Quests take a long time to complete, and this was observed as one of their difficulties.

Beyond the lack of time to complete activities, other obstacles cited were related to (a) the schedule of the group's meetings - as classroom activities were executed during Saturday mornings, and some students had trouble with this; and (b) the existence of other higher priorities activities, like other courses. Yet, these are not problems related to the gamified experience per se.

Students also reported that the study group was a valuable aid to their learning/studying process. According to them, activities helped them with a better understanding and retention of content as well as a recap of what they had studied in the classroom.

As for the gamified experience and the game elements, interviews revealed that they could perceive and appreciate the game-like experience. Most of their comments on game elements were related to the quizzes, the quests, and, to a lower extent, the points system. Not so much was said about competition and collaboration elements. We designed the experience with a few components to promote these, and they did not seem to miss that.

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