ScrumGame: A Serious Game to Initiate Software Trainees in Scrum

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Abstract. Serious games have emerged to improve the commitment and performance of users, since they accomplish a specific goal, integrating with the mechanics of the game, thus creating a very attractive mission. The use of serious games in Software Engineering to increase developer engagement has been investigated with great interest to train future professionals to experience situations that they might face in software development. This work presents *ScrumGame*, a serious game to train both Software Engineering students and software practitioners in Scrum. The game was assessed through pre-test-post-test design with 10 users who use Scrum in their daily work. For this, the SIMS and MSLQ tests were used, which both were completed by the users before and after playing the game. We aimed to measure how the use of the game impacts on learning strategies and motivation. Backed up with statistical significance support, results show that *ScrumGame* generated a positive impact on the users, indicating an increase in the variables studied, key issues in the development of self-managed education.

Keywords: Scrum; Serious Game; Software Engineering Education; m-learning; SIMS; MSLQ

1 Introduction

In recent years, the use of agile methodologies such as Scrum has grown significantly. According to a 2019 survey conducted by Forbes Insights and Scrum Alliance [1], 81% of executives consider agility as the most important characteristic of a successful organization, due to its ability to respond to changing priorities and the visibility of your projects. Furthermore, 76% of surveyed companies use Scrum or hybrid approaches involving Scrum [2]. These results provide several insights about Agile are nowadays the de-facto methodologies in the software industry. This issue implies a clear need for workers prepared to adapt to this development methodology.

Along this line, universities and educational entities are including the teaching of agile methodology within their study plans [13], for which they employ different

learning strategies. Thus, universities need to effectively provide students with the skills needed to succeed in current software organizations. In particular, experience-based learning techniques, such as games, have been widely used. Among these, the use of a LEGO-based simulation game to teaching Scrum [3]; Scrum-X, a spreadsheet-based simulation game for teaching Scrum [4]; Scrumi, an electronic board serious game for teaching concepts inherent to the SCRUM framework [5]; and a gamified system oriented to mobile platforms that allows applying the Scrum process from the Scrum Master's viewpoint [6], among others.

In this work, we have built *ScrumGame*, a serious game developed for the iOS platform. The game aims to train both software engineering students and software practitioners in Scrum by exploiting gamification design and ubiquity. Learning with *ScrumGame* could be fun and addictive; user can earn points for correct answers, for racing against the clock and for leveling up. To validate the game, user tests were carried out with 10 employees of a software development company focused on the development of mobile games that use Scrum in their daily work. We aimed to analyze psychological variables, such as motivation and learning-oriented strategies. For this analysis, two validated questionnaires were used: the SIMS (Situational Motivation Scale) [7] and the MSLQ (Motivated Strategies for Learning Questionnaire) [8], both carried out before and after using the application, with the intention of observing how the use of the game impacts on the variables under study. In addition, we aimed to obtain feedback on important aspects related to games, such as engagement, level of enjoyment and possible future improvements, through interviews. As main results, it was obtained that most of the variables under study in both tests showed positive changes. These insights showed that the use of our game generated a positive impact on the users, both in the learning strategies as motivation, which are crucial issues in the development of self-managed education.

The remainder of this paper is structured as follows. Section 2 describes the background. Section 3 introduces our serious game approach. Section 4 reports the assessment of the approach. Finally, section 5 concludes our work and identifies future line of research.

2 Background

Scrum is a framework by which people can tackle complex adaptive problems, where requirements are changing or poorly defined, while delivering incremental value products. According to the last annual survey carried out by the State of Agile in 2020 [2], Scrum is the most used agile methodology with 66%, which, considering also the hybrid combination Scrum and other frameworks, give a total 76%. This methodology consists of teams and their associated roles, events, artifacts, and rules. Each component within the framework serves a specific purpose and is essential to the success of a software application. Scrum ensures that knowledge comes from experience and from making decisions based on what is known. From there, its iterative and incremental approach optimizes predictability and risk control.

The use of games and mobile platforms has boomed as a constant source of learning. In particular, improving the teaching of Scrum to both students and

practitioners has been the subject of research to replace or complement traditional teaching methods. In this context, m-learning learning strategies will allow users to learn Scrum anywhere, anytime.

Gamification is a term that refers to the use of techniques, elements and dynamics typical of games in non-recreational systems in order to enhance motivation, to reinforce behavior to solve a problem, and to improve productivity [9]. Furthermore, gamification is used to improve user experience and the level of commitment and participation of users [10]. More specifically, according to [11] the importance of its application has several reasons, such as activation of the motivation for learning, constant feedback, facilitation of more meaningful learning, commitment to learning, more measurable results such as levels, points and medals, generation of adequate skills, digital alphabetization, generation of autonomous learners, and development of competitiveness as well as collaboration, among others.

Serious games were conceived within the variety of games for a primary purpose beyond mere fun [14]. They aim at a wide variety of audiences, from primary and secondary school students to professionals and consumers. Serious games can be of any genre, use any game technology and be developed for any platform. They are made to provide a context of entertainment and self-empowerment with which to motivate, educate and train users. These games seek to improve learning; they aim to strike a balance between studio content and the gameplay and ability of the player to retain and apply that content in the real world. They are also widely used in the business world to improve employee skills.

3 Our Serious Game Approach

This section presents the approach used to develop the *ScrumGame* application. This game aims to support Scrum teaching and training both in academic fields and professional contexts. To deal with this issue, a mobile application was implemented, using gamification, serious games and game-based learning concepts. Fig. 1 depicts a snapshot of *ScrumGame* in action.

The structure of the game content will be presented as follows. *ScrumGame* has a series of levels, which will divide the information into the main topics. Each topic has a series of sub-levels, which divide the content of the level into sub-themes within the main theme. Each sub-level is divided, in turn, into two main parts. On the one hand, the theory shows the theoretical information of the topic within a sub-level. The theory is presented in pages. Each page, like a page of a book, shows the data that the user will need to face the game. On the other hand, a sub-level is divided into games, which are presented in different formats to enrich users' learning experience.

A level has certain information to provide the user with a context. The level highlights the title of the topic, the number of sub-levels necessary to complete to advance to the next one, and the percentage of completeness of the level. This value is obtained by analyzing the percentage of completeness of the contained sub-levels. In addition, the level contains a state, which shows its current situation, namely locked, started and finished. *Locked* means that the level cannot be started because the previous level was not completed. *Started* means that the level is started or ready for

the user to start it. Finally, *finished* means that the level was successfully completed by the user.

Fig. 1 Snapshot of *Scrum Game* in action.

Each sub-level also has a title, a status and a percentage of completion. Each sub-level is made up of theoretical information on the sub-topic discussed, which is presented to the user in the first instance. Furthermore, a sub-level also contains a series of games where the user can put into practice the concepts learned in the theoretical section, as well as give rise to possible more interpretative theoretical derivations. The completeness of the theoretical concepts and the number of successfully completed games of a sub-level will be used to compute the percentage of completeness that will be presented to the user.

Each sub-level has a theoretical section, where the user can find out about the concepts required to complete that level. For this, the information is presented in pages, which will be made up of different components, as required. A page consists of a title, paragraph, image and video.

The theory module has a control to advance or go back the pages of the game, showing different options depending on the page where the user is. This movement can also be achieved by performing a lateral slide, also known as swipe left/right. In addition, the concept of "Jump" is introduced, which allows users to go directly to the Games module, if they prefer. This definition stems from the need to avoid being pushed to revisit concepts by experienced users. The theoretical section will be considered complete if a user presses the play button or the skip button at the end of the section. The sub-level games section consists of a set of games prepared to give a user a way to validate the concepts learned in the theoretical section, presented in an attractive and motivating way.

Two main types of games are defined in *ScrumGame*: static and dynamic. The former is a non-modifiable game. Its implementation was thought from the beginning to meet a game objective and a particular theme; it belongs to a specific level. The latter is a game that can be reused, since the value of it is in its content. In this case, this is a game where the gameplay module will obtain the necessary information to

display it and the correct values to complete it. Fig 2 illustrates 2 games developed in *ScrumGame*. Some games are based on multiple-choice (Fig. 2a) or drag-and-drop (Fig. 2b) strategies, among others. All the games aim to assess Scrum concepts according to the knowledge level gained by the user along the game. Particularly, games depicted in Fig. 2 propose to train users in the life-cycle of Scrum and the artifacts and events used along the methodology. The goal in the game (b) is to drag the components (Scrum artifacts or event) and drop them in the correct place of the Scrum framework.

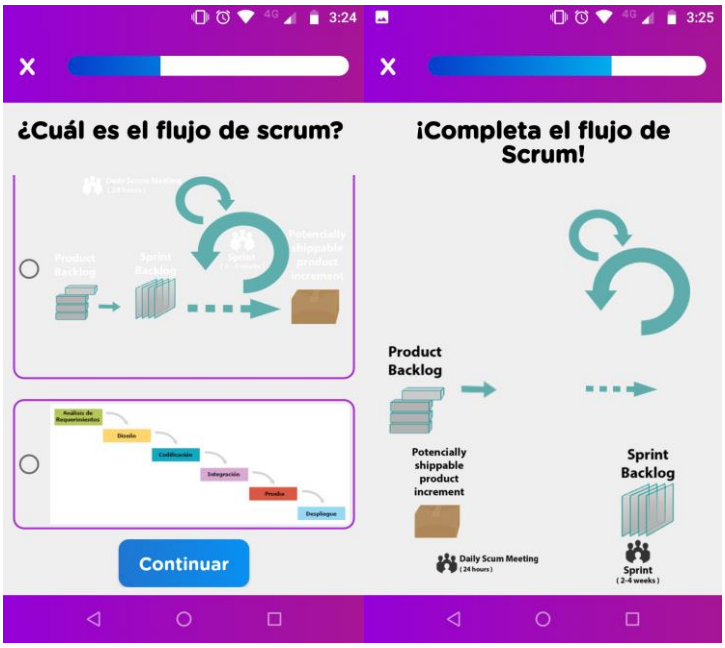

Fig. 2 Example game strategies developed in *ScrumGame*: **(a)** Multiple-choice **(b)** Drag-and-drop.

Once the user submits a correct response, the game notifies the main controller so that it can stop the game timer. Meanwhile, it shows the user a message that the game was completed successfully and waits for their interaction. When the user agrees to continue, the main controller is notified to prepare for the next game, and also sends the "correct answer" and "total game time" events to the server. Finally, the main controller removes controller for the recently completed game, leaving room for the next game. It should also be noted that when completing each game within the sublevel, the main controller sends the progress data for storage. For its local save, *ScrumGame* uses Realm (https://realm.io/), while for its persistence in the cloud, the game uses Firebase (https://firebase.google.com/?hl=en).

4 Experimental Results

The goal of the evaluation is to measure the impact of *ScrumGame* on learning experience and motivation of users. To meet our objective, we used a pre-test-post-test design. To do this, two different tests were utilized: the SIMS (Situational Motivation Scale) [7] and the MSLQ (Motivated Strategies for Learning Questionnaire) [8]. Before playing, the users participating in the evaluation completed the tests and, after experiencing a given scenario with *ScrumGame*, the users completed the same tests again.

4.1 Setup

For the development of the experiment, 10 users took part in the experience, of whom 7 were men and 3 women. All participants are employees of a software development company focused on the development of mobile games. They are in the age range of 25-40 years old and the distribution of roles is described as follows: Project Manager (1), UX/ UI Designers (2), Technical Leader (T1), Developers (2), Product Owner (2), DevOps Leader (1). Particularly, in this company, knowledge of Scrum is not a mandatory requirement, since each team is organized with the methodology that best suits their projects and members. This allowed the participants to have different initial background of Scrum when conducting the experiment.

4.2 Pre-test and Post-test

Two of the important psychological variables to consider in self-managed education are motivation and the learning strategies. In this work, 2 instruments were used: the MSLQ and SIMS tests. The former is a self-report instrument that has been used in research to assess students' motivation and beliefs, among other aspects. This information is useful for evaluating strengths and difficulties of a student and, according to these, optimizing learning. The latter is a situational questionnaire, used to measure motivation. It seeks to judge the constructions of intrinsic motivation, identified regulation, external regulation and amotivation.

To answer the questionnaires, a Likert scale was used, which is the most widely used psychometric scale in research surveys, mainly in the social sciences. When answering a question from a questionnaire developed with the Likert scale, the level of agreement or disagreement with a statement is specified [12]. In our experiment, participants were asked to agree with a statement giving a value from 1 (does not correspond at all) up to 7 (totally corresponds) for SIMS.

In our case, the Motivation and Learning Strategies Questionnaire Short Form – CMEA FC [7] was used, which is the result of the translation and adaptation into Spanish of the MSLQ, in its reduced and validated version. The short form consists of 40 items with a Likert scale of 5 points, which goes from 1 (Never) up to 5 (Always). The short form is structured as follows with the corresponding dimensions (i.e. items): Motivation variable is determined by three items that evaluate the assessment of the task and four items that assess the anxiety under examination situations.

Regarding the Learning Strategies variable, the cognitive and metacognitive strategies, resource management strategies and intrinsic orientation were organized in the following way: five items to evaluate the elaboration strategies, four items to consider organization strategies, three items to assess critical thinking, and seven items to take into account self-regulation to metacognition. The Resource Management Strategies are defined as follows: six items to evaluate study time and habits, six items to talk about self-regulation of effort. And finally two items evaluate the goals of intrinsic orientation.

The SIMS test seeks to judge the constructions of intrinsic motivation, identified regulation, external regulation and amotivation, in a short and versatile way, both in field and laboratory studies [8]. It corresponds to 16 statements that the user must assess, according to the Likert scale, as detailed in the following section. These 16 statements are structured as follows along with the corresponding dimensions: Intrinsic motivation (4 items), Identified regulation (4 items), External regulation (4 items) and Amotivation (4 items).

4.3 Psychological variables under study

For our analysis, six psychological variables were taken into account during the experiment: two variables from MSLQ (Learning Strategies and Motivation) and four variables from SIMS (Intrinsic Motivation, External Regulation, Identified Regulation, and Amotivation).

- Learning Strategies: it talks about the imposition of own goals, distribution of time and effort, repetition, organization, critical thinking, and other cognitive processes that determine the acquisition of information, its processing and recovery. This variable is ranged from 33 to 165.
- Motivation: this variable consists of all the internal determinants that stimulate action. Motivation activates, directs and maintains a behavior. In this factor, micro variables such as the assessment of the task to be carried out and the management of anxiety are evaluated. This variable ranges from 7 to 35.
- Intrinsic Motivation: it is a motivation originated within the individual, and is directed by the needs of exploration, experimentation, curiosity and manipulation, which are considered motivating behaviors in themselves. That is, those behaviors that are carried out in the absence of any apparent external contingency are considered intrinsically motivated. The range of this variable is [4...28].
- External regulation: is a prototype of motivation not generated by one. Externally regulated behaviors are carried out to obtain a reward or satisfy external demand. The range of this variable is [4...28].
- Identified Regulation: represents an extrinsic motivation that is internalized and autonomous. They are behaviors regulated by personally important aspects. The range of this variable is [4...28].
- Amotivation: lack of motivation causes individuals to experience a lack of contingency between their behaviors and their results. Unmotivated behaviors are the least self-determined because there is no sense of purpose

and there are no expectations of reward or possibility of changing the course of events. The range of this variable is [4...28].

4.4 Hypothesis Statement

For all variables under study, we defined null hypothesis and alternative hypothesis as follows. Null hypothesis (H_0) states that there is no significant difference between the pre-test and post-test values for the variable under study (*p-value* $\geq$ 0.05). The alternative hypothesis (H_1) states that there is a significant difference between the pre-test and post-test values for the variable under study (*p-value* < 0.05). The hypotheses were corroborated by utilizing the two-tailed Student t-Test with SPSS tool.

4.5 Results

This section reports the results obtained after conducting both tests and analyzing the means for each pair of psychology variables (before-after). All the null hypotheses were rejected and consequently the alternative hypotheses accepted (*p-value* < 0.0001).

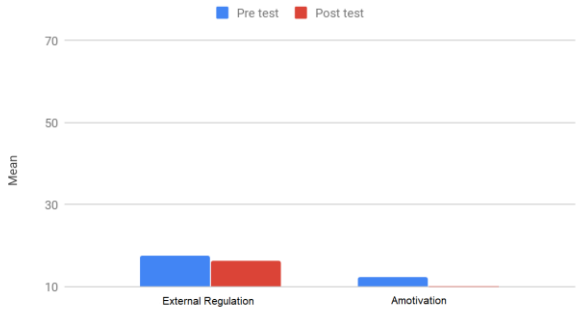

Fig. 3 Comparison of means of External Regulation and Amotivation in pre- and post-test.

Fig. 3 depicts that External Regulation showed a slow decay (from 17.6 to 16.4). In other words, all those motivational behaviors driven by strictly external stimuli decreased in the post-test, after using *ScrumGame*. Regarding the Amotivation, Fig. 3 shows decay after the post-test (from 12.4 to 7.5). Positively, the lack of motivation fell in the post-test. This variation could mean that the users found a sense of purpose within the game. As can be seen in Fig. 4, Intrinsic Motivation has risen after using the game (from 20.1 to 23.8). Similarly, the Identified Regulation, understood as those external motivations that users understand and accept as their own, increased slightly in the post-test (from 23.8 to 22.8). Fig. 5 illustrates that Motivation values slightly decreased after using *ScrumGame* (from 28.0 to 27.7). In this case, the variables related to the assessment of the task and anxiety management decreased in the post-test. This unfavorable result could be attributed to the lack of psychological

preparation in games and in the application in general, to improve key concepts that affect this variable, such as competition and anxiety management.

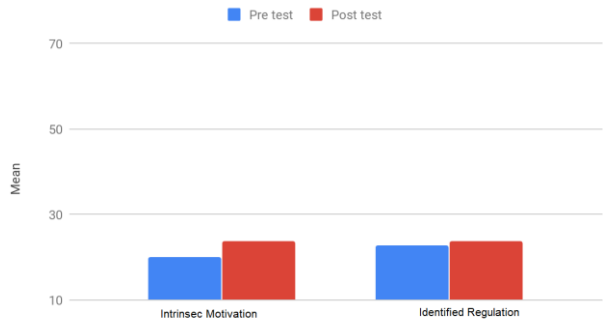

Fig. 4 Comparison of means of Intrinsec Motivation and Identified Regulation in pre- and post-test

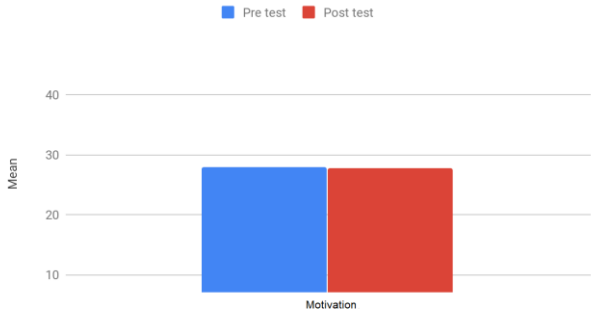

Fig. 5 Comparison of means of Motivation in pre- and post-test.

As for Learning Strategies, Fig. 6 shows that this variable has increased in the post-test (from 163.4 to 169.2). The micro variables related to this aspect, such as the imposition of own goals, distribution of time and effort, among others, improved after playing *ScrumGame*.

5 Conclusions

In this work, we presented a serious game for teaching Scrum. After the evaluation carried out through a pre-test-post-test design experiment with 10 users, we concluded that most of the psychological variables under study showed positive changes after the post-test. We can affirm that the use of *ScrumGame* significantly showed a positive impact on users, both in learning-related strategies and motivation.

Fig. 6 Comparison of means of Learning Strategies in pre- and post-test.

As future work, firstly, we propose to generate new games with a psycho-pedagogical perspective, in order to optimize the learning experience and obtain better results. Secondly, we plan to incorporate more games to simulate real complex situations, serving as practice for specific scenarios in professional contexts. Thirdly, by using the users' feedback, we will work on improving techniques and components related to gamification issues, in order to generate higher commitment, fun and motivation from users. Finally, we aim to apply data science to the data generated along the game sessions to discover knowledge and assist users in their learning experience.

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