Gamifying Requirements Engineering for Better Practice

Mohammed El Amin.TEBIB
Centre de Recherche en Informatique (CRI)
Université Paris 1 Panthéon-Sorbonne, Paris, France
Mohammed-El-Amin.TEBIB@univ-paris1.fr

Abstract

[**Context**] Although Requirements Engineering (RE) is recognized as a critical factor for the success of software and systems development projects, RE related issues are still in the top ten root causes of partial or complete project failures. There are multiple reasons why RE is often neglected or poorly conducted: poor knowledge of the RE methods, techniques and tools, entanglement of problems, practitioners having poor soft skills, stakeholders' effectiveness and engagement decreasing rapidly, just to name a few.[**Relevance**] We need more attractive and motivational ways to make stakeholders skilled and properly engaged for efficiently achieving all RE activities. The research community indicated that gamification would be an effective tool to increase performance, creativity and improve the quality of software products in current organizations. [**Research Project**] This paper describes a gamified approach to make RE' methods, tools and activities more attractive and easier to be learned and used, and that based on games' concepts and logic. [**Contribution**] The research will provides an approach that offers more games for all RE' activities, and evaluates rigorously their effectiveness to improve RE' training and RE' application. [**Research method**] We follow a design science approach to produce RE games. To experiment with the introduction of these games in the academic and industrial fields, the design, evaluation and validation of the methodology will follow three stages : 1) Design a series of RE games, each game tackles a specific problem and/or activity related to RE; 2) Test each game with BSc or/and MSc students at universities, and experts from real software production organisations; 3) Evaluate the effectiveness of these games through interviews. [**Progress**] In a early stage of research (from the begening of 2019), a series of RE games (13 games) are collected, we plan also to perform interviews with RE experts to better adapt and evaluate these games to fit their needs, then invent new games that tackles the other RE' activities.

Keywords: Gamification, Games, Requirements Engineering, Education & Training, RE Activities, Gamified Requirements Engineering.

1   Introduction

Various definitions have been assigned to the term Gamification such as, Deterding et .al "The use of game elements in non-game contexts" [det2011]. Kapp et .al "gamification is using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" [Kapp2012]. Gamification is increasingly used for training. Indeed, games are recognized as an effective mechanism to achieve deep learning and help students retain information [Alexander2008]. This approach has considerable attention by research and industrial communities in different areas such as Health [Lister2014], Automation [Marasco] and many more. In Software Engineering, gamification has been used for increasing the engagement of developers and improve their results [Pedreira2015]; Allowing organizations to adapt their processes evolution by proposing a business process modeling method based on a simulation role-playing game tool [Santorum2011]; and Creating a more productive developers teams using rewards as a game element by analysing changes introduced by each developer [de2014]. According to the results of these works, we see that gamification can be a powerful tool to deal with shortcomings and problems of RE. Although RE is a 30 years old science, we still know very little on the most efficient ways to educate, train and motivate RE practitioners during their practice, and our theory is that games have the power to improve that. The goal of this work is to present an approach to increase the employment of gamification in requirements engineering in order to make its methods, tools and activities more attractive, efficient and easy to use.

The article is organized as follow: Section 2 highlights our research motivations. A short literature overview of requirements engineering games focusing on teaching, training and activities is presented in Section 3. An overview of our proposal is given in section 4. Finally, we discusses our work agenda in order to reach the final goal in Section 5.

2   Motivation

The starting point is twofold, from literature review and current practices. The idea of applying gamification in requirements engineering is still quite young, we still need to make stakeholders more involved in requirement engineering activities. Furthermore, the proposed games presented in Section 3 for gamifying some aspects of requirements engineering is a good starting point, but is not enough. Experiments of these games have indicated that they will not solve all problems of RE. On one side a lot of RE' activities not yet gamified, the proposed games focus more on requirements elicitation, while there is other RE' activities that could be gamified such as: analyse, specification, validation, etc. In the other side there are some shortcomings in current evaluation practices such as : (1) the lack of evaluation in some primary studies (4 out of 13 games not evaluated), (2) Low number of qualitative and quantitative studies [dos2018]; and (3) the lack a proper technological support, for controlled studies demonstrating reliable positive or negative results of using specific games in particular educational contexts [Lombriser2016]. Also to achieve better RE practices there are few other important aspects that need to be tackled using games, among those we can list:

- Comprehension: The RE knowledge is still not being transmitted effectively and organizations seem unfamiliar with techniques [Juristo2002], experts need to master (project leaders, functional architects, business analysts, etc) during their missions.

- Soft skills: Most requirements engineers and their project managers are not (or not enough) aware of the need for soft skills [Penzenstadler2009], Requirements Analysts need to have a combination of technical and soft skills such as empathy, creativity, listening, analytical thinking, confidence, ability to convince, conflict resolution, perseverance, quality of expression to conduct effective requirements elicitation interviews [Bano2018]. We need more dynamic and motivational ways to assist the teaching of these kind of skills which are not well mastered, in current organizations .

- Requirements Documentation: Current techniques used for requirements documentation (e.g. textual representation) are very hard to be communicated, understood or used for the detection and the resolution of conflicts [Pinto2014].

- Inculture: Many stakeholders actually have a very limited culture on RE and more broadly, software engineering, project management, innovation. "Many recent studies have demonstrated that the traditional methods used in teaching software requirements elicitation are ineffective because they frequently produce unskilled graduates who are inappropriately trained to apply their practical knowledge in the workplace.

This is due to ineffectiveness of teaching methods that produces unskilled graduates who are inappropriately trained to apply their practical knowledge in the workplace" [Garcia2019]. We need more attractive ways to improve stakeholder' culture in these domains.

- Traceability and communication: Requirements engineering activities especially elicitation has been taught by means of traditional methods they don't focus enough on the most important skills during requirements gathering which are communication and traçability [Zapata2010].

Our vision intends to contribute in reducing these limitations.

3 Related Works

The use of gamification to improve stakeholder experience, satisfaction and awareness in requirements engineering has recently received some attention from the research community. Based on an ad-hoc literature review, Figure 1 lists the works we could identify on the topic.
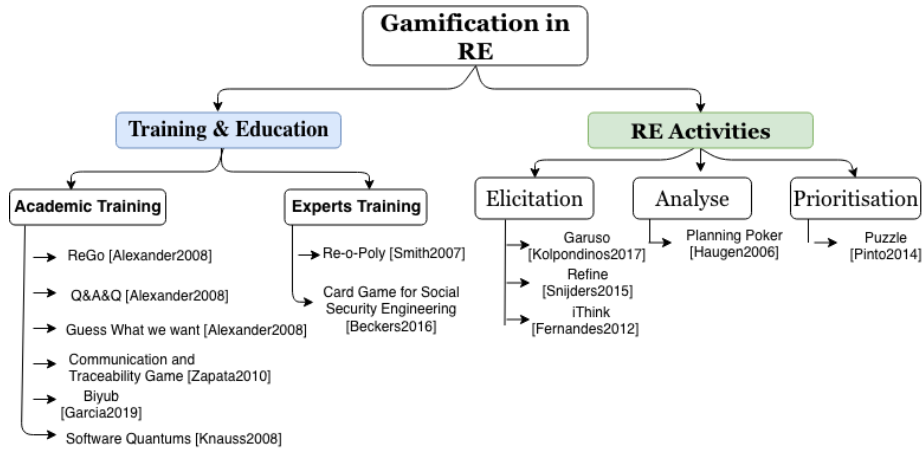

Figure 1: Requirements Engineering Games

As the Figure 1 shows , 2 approaches can be distinguished: (1) Games to improve requirements engineering training and education, and (2) games to increase the engagement of stakeholders in front of requirements engineering practices and activities. For Training and education, a number of games are mainly constructed for (i) academic training, and tested in universities during requirements engineering courses. The goal to make the teaching of RE with more fun and more natural. Among these games : ReGo inspired from the Bingo game that is used to assess students' knowledge about the course topics at the beginning of the course [Alexander2008] ; Q&A&Q (Question, Answer, Question) game where a player answers a question then another player guesses what is the question starting from this answer in a iterative process. This game is used by teachers during requirements elicitation course to help students recognize the differences and similarities among three primary requirements elicitation methods. It shows how they might disagree on seemingly simple concepts, by providing an opportunity to see how those concepts differ and overlap [Alexander2008]; Biyubi game is role-based game to facilitate the learning of requirements elicitation activities on an undergraduate software engineering course [Garcia2019]; Guess what we want game, that helps requirement's engineers better understand the importance and impact of their work. In this game players guess a design of the solution starting from requirements that are not well detailed. The real message behind the game is to help students understand following points: (1) the different levels of the requirements hierarchy, (2) why detailed requirements are necessary for successful projects, (3) what happens when detailed requirements are not provided to system designers; Communication and traceability game [Zapata2010] is role-based game that aims to reinforce communication and traceability skills used for requirements elicitation process ; In Software Quantums [Knauss2008] game, requirements called quantums that are represented using colored balls and classified using bags. It is a simulation game to teach students how to build the right system within the available time .

While these games were designed for university students, another set of games are specific for experts can be identified: the best example is Re-o-Poly game derived from the famous game 'monopoly', the goal was to use

this game to introduce requirements engineering best practices to novice organisations via managing projects in the game [Smith2007]; also Customized card game for social engineering security that introduced security awareness to different employees in order to face security threats [Beckers2016]. Experiments of these games demonstrated that they can contribute to improve the education and the leaning of learners in requirements engineering. Few works tackle requirements engineering activities (elicitation, analyse, prioritization) with the goal to increase the engagement of users doing this activities, and that based on different games concepts such as points, badges, levels, stages, etc. As an example CaRuso platform is based on points and levels as a game elements to motivate stakeholders (in particular external users) to contribute to the requirements prioritization process [Kolpondinos2017]; Refine platform aims at enlarging participation in RE by involving a crowd of both internal and external stakeholders, badges, feedback and points have been used to increase motivation and users' engagement [Snijders2015]; Ithink is designed to stimulate parallel thinking and increase group discussion [Fernandes2012]; JigSaw Puzzle game used during stakeholders' meetings to analyze conflicts in the presented requirements. The ultimate goal being to handle these conflicts [Pinto2014]. The Planning poker game is currently used in agile projects for requirements prioritization [Haugen2006].

4 Research Project

Games could be an effective tool for (1) engagement: game elements and concepts such as points, badges, chances, fun, etc, may be employed on any system or activity in order to increase the engagement of stakeholders. (2) Culture, questions games or dictionary games could be invented especially as culture games to teach the main concepts of requirements engineering. In addition Games provides playful aspects that could be used to better communicate, understand and resolve conflicts in requirements expression for such system [Pinto2014], and for that requirements documentation could be a target using games' artefacts like puzzles or cards. Social game could be invented to develop stakeholders' (4) soft skills, these games would be used for experts during training days. Games also could be used to increase RE (5) comprehension, so gamifying RE methods, techniques and tools should also improve their understanding [Salinesi2015]. For (6) traceability and communication, games could be used to teach social and managerial skills related to these issues that are used for requirements elicitation.

In our approach we aim to follow an iterative process, in a first step we'll conduct interviews to have a better understanding of the kind of games to use among our games toolbox. We will then collect these games, and invent new ones tackling other activities to increase the prevalence of gamification in requirements engineering. These games will be tested in their early stages with BSc or/And MSc students within Paris 1 University, then in a controlled environments simulating software production organizations. To achieve more rigorous evaluation we will rely on two methods: (1) feedbacks of players will be measured basing on questionnaires that will be formulated based on some criteria such as real-world relevance, fun factor, participants involvement, intellectual stimulation, knowledge (not chance), etc; (2) GREM [Lombriser2016] model will be used as a rigorous controlled experiment, that is based on a specific variables and algorithms for accurately measuring some artefacts such as: motivation, emotions, cognition, etc.

The research presented in this paper is based on a number of important underlying assumptions that are formulated starting from the related research studies:

- Assumption 1: "Games are used both for the RE activities, but also for related activities such as RE training, or some other activities (business analysis, project management, etc) that require to have RE skills".

- Assumption 2: "Any activity of RE can be gamified (elicitation, specification, negotiation); as well as any transversal activity of the RE (validation, planning, testing, management,)".

- Assumption 3: "Games can be invented especially for RE (such as poker planning), or we can adapt existing games (such as Re-o-Poly, Puzzle)".

The major goal of our research is to construct a generic toolbox that collects the set of games we have found and a few more that we are inventing to improve results of RE phases, get better productivity and engage stakeholders better, this toolbox would be used for (1) requirements engineering education training, and (2) during the practice of requirements engineering activities in industry.

5   Conclusion

The idea of the project is discussed with many experts in both industrial and academic fields with an encouraging feedbacks. Industrials express the need of these kind of solutions to develop several skills for their employees on one hand, and on the other hand making theme more engaged to realize such activities especially during meetings. In the academic field, RE' Professors express the importance to adopt this solution in order to increase the motivation and ability of students to RE courses which are abstract and difficult to understand.

As mentioned in Section 4, following a design science approach, our initial goal is to understand how we could motivate students and/or experts to achieve better RE training and/or practices using games, we think that interviews will be a good starting point to realize that. This kind of initial discussion will help us to get a more clear idea about the games to use among our toolbox. These games will be tested in their early stages with BSc or/And MSc students within Paris 1 University, then in a controlled environments simulating software production organizations. Finally, to survey the effectiveness of our solution, more rigorous techniques will be used such as: (1) more qualitative and quantitative studies; (2) rigorous formulated questionnaires ;(3) GREM model. The obtained results will help us to improve these games. Once the effectiveness of the invented games is evaluated, this toolbox will be delivered to be used in the industry, to improve RE practices and training for experts in software products organization.

References

[det2011]   Deterding, Sebastian and Sicart, Miguel and Nacke, Lennart and O'Hara, Kenton and Dixon, Dan Gamification. using game-design elements in non-gaming contexts *CHI'11 extended abstracts on human factors in computing systems*, 2425–2428, 2011. ACM.

[Smith2007]   Smith, Renel and Gotel, Orlena Using a game to introduce lightweight requirements engineering *15th International Requirements Engineering Conference (RE 2007)*, 379–380, 2007. IEEE.

[Beckers2016]   Beckers, Kristian and Pape, Sebastian A serious game for eliciting social engineering security requirements *24th International Requirements Engineering Conference (RE 2016)*, 16–25, 2016. IEEE.

[Alexander2008]   Alexander, Mike and Beatty, Joy Effective design and use of requirements engineering training games *Requirements Engineering Education and Training*, 18–21, 2008. IEEE.

[Zapata2010]   Zapata Jaramillo, Carlos Mario Communication and traceability game: a way to improve requirements elicitation process teaching *Revista Facultad de Ingeniería Universidad de Antioquia*, 213–221, 2010.

[Pinto2014]   Pinto-Albuquerque, Maria and Rashid, Awais Tackling the requirements jigsaw puzzle *IEEE 22nd International Requirements Engineering Conference (RE)*, 233–242, 2014, IEEE.

[Kolpondinos2017]   Kolpondinos, Martina Z Huber and Glinz, Martin Behind Points and Levels—The Influence of Gamification Algorithms on Requirements Prioritization *25th International Requirements Engineering Conference (RE)*, 332–341, 2017, IEEE.

[Snijders2015]   Snijders, Remco and Dalpiaz, Fabiano and Brinkkemper, Sjaak and Hosseini, Mahmood and Ali, Raian and Ozum, Atilla REfine: A gamified platform for participatory requirements engineering *1st International Workshop on Crowd-Based Requirements Engineering (CrowdRE)*, 1–6, 2015, IEEE.

[Knauss2008]   Knauss, Eric and Schneider, Kurt and Stapel, Kai A game for taking requirements engineering more seriously *Third International Workshop on Multimedia and Enjoyable Requirements Engineering-Beyond Mere Descriptions and with More Fun and Games*, 22–26, 2008, IEEE.

[Pedreira2015]   Pedreira, Oscar and García, Félix and Brisaboa, Nieves and Piattini, Mario Gamification in software engineering–A systematic mapping *Information and software technology*, 157–168, 2015, ACM.

[Juristo2002]   Juristo, Natalia and Moreno, Ana and Silva, Andrés Is the European industry moving toward solving requirements engineering problems? *software*, 70–77, 2002, IEEE.

[Penzenstadler2009] Penzenstadler, Birgit and Haller, Gabriele and Schlosser, Tobias and Frenzel, Gabriele Soft Skills REquired: A practical approach for empowering soft skills in the engineering world *Collaboration and Intercultural Issues on Requirements: Communication, Understanding and Softskills*, 31–36, 2009, IEEE.

[Salinesi2015] Salinesi Camille, Agnés Front Ingénierie par et pour les jeux sérieux , 2015.

[Kapp2012] Kapp, Karl M The gamification of learning and instruction: game-based methods and strategies for training and education , 2012, John Wiley & Sons

[Lister2014] Lister, Cameron and West, Joshua H and Cannon, Ben and Sax, Tyler and Brodegard, David Just a fad? Gamification in health and fitness apps *JMIR serious games*, 2014,

[Marasco] Marasco, Emily and Behjat, Laleh and Eggermont, Marjan and Rosehart, William and Moshirpour, Mohammad and Hugo, Ron Using gamification for engagement and learning in electrical and computer engineering classrooms *Frontiers in Education Conference (FIE)*, 1–4, 2016, IEEE

[Garcia2019] Garcia, Ivan and Pacheco, Carla and León, Andrés and Calvo-Manzano, Jose A Experiences of using a game for improving learning in software requirements elicitation *Computer Applications in Engineering Education*, 2019, Wiley Online Library,

[Bano2018] Bano, Muneera and Zowghi, Didar and Ferrari, Alessio and Spoletini, Paola and Donati, Beatrice Learning from Mistakes: An Empirical Study of Elicitation Interviews Performed by Novices *26th International Requirements Engineering Conference (RE)*, 182–193, 2018, IEEE.

[de2014] de Melo, Alexandre Altair and Hinz, Mauro and Scheibel, Glaucio and Berkenbrock, Carla Diacui Medeiros and Gasparini, Isabela and Baldo, Fabiano Version Control System Gamification: A proposal to encourage the engagement of developers to collaborate in software projects *International Conference on Social Computing and Social Media*, 550–558, 2014, Springer.

[Santorum2011] Santorum, Marco Oswaldo and Rieu, Dominique and Mandran, Nadine and others Approche de gestion des processus basée sur les jeux *Revue des Sciences et Technologies de l'Information-Série ISI: Ingénierie des Systèmes d'Information*, 33–59, 2011,

[Haugen2006] Haugen, Nils Christian An empirical study of using planning poker for user story estimation *AGILE 2006 (AGILE'06)*, 9–pp, 2006, IEEE.

[Fernandes2012] Fernandes, João and Duarte, Diogo and Ribeiro, Claudia and Farinha, Carla and Pereira, João Madeiras and da Silva, Miguel Mira *Procedia Computer Science*, 66–77, 2012, Elsevier.

[Lombriser2016] Lombriser, Philipp and Dalpiaz, Fabiano and Lucassen, Garm and Brinkkemper, Sjaak International Working Conference on Requirements Engineering: Foundation for Software Quality , 171–187, 2016, Springer.

[dos2018] dos Santos, Adriano Lages and Maurício, R de A and Figueiredo, Eduardo and Dayrell, Marcella Game Elements for Learning Programming: A Mapping Study. *CSEDU (2)*, 89–101, 2018.