2018 International Conference on the Quality of Information and Communications Technology

Gamification in Requirements Engineering: a Systematic Review

Rodrigo Cursino, Daniel Ferreira, Maria Lencastre, Roberta Fagundes, João Pimentel

Abstract—Gamification has been applied to a large diversity of settings in recent years, with encouraging and promising results. In the Software Engineering context, there are some research works that focused on the application of gamification in Requirements Engineering that need to be better analyzed and understood. Does gamification impact RE? What are the gamification elements that have been used? What sub-processes and RE tasks have been the subject of gamification? The objective of this paper is to carry out a systematic review to characterize the state of the art of gamification in RE, answering those and other questions, identifying gaps and opportunities for further research. It was conducted a systematic review to find the primary studies in the existent literature which objectives is applying gamification to RE and its sub-processes. As a result of the systematic review, 8 primary studies were analyzed. They were published between 2012 and 2017 and most of them focus on the application of gamification onto elicitation, negotiation and prioritization.

Index Terms—Requirements Engineering, Gamification, Systematic Review

1 Introduction

Properly eliciting requirements is a critical task for the success of software projects [1]. Many projects continue to fail and some of the reasons are poor requirements elicitation and documentation, with open definitions and low involvement of users [2], [3].

Requirements are the core of any system [4] and require a lot of attention from all stakeholders. They describe the system, its behavior, its functionalities, its restrictions and all its attributes [5]. The Requirements Engineering (RE) process involves eliciting, documenting, validating, prioritizing and managing the requirements [6]. However, because it is a laborious, tedious and sometimes boring task, it ends up not receiving due attention from stakeholders.

In recent years, however, one approach has drawn attention in several areas of application in order to make tedious, low-interest, long and repetitive tasks into something more enjoyable and fun. Gamification is used when elements typically found in games are applied in situations, activities, and contexts that are not games [7]. Several works have already proven that game elements can positively affect emotions, reduce stress, create strong social relationships, increase the sense of fellowship and collaboration, and significantly increase cognitive abilities [8]. That is, using even a subset of game elements in business contexts or in software processes it is possible to achieve increased success rates. Thus, it is important to understand how and where gamification has been used within software projects, where it has been most effective and particularly, which RE subprocesses and tasks have benefited the most from it. Among the most varied gamification elements, which have been more explored in the literature and which other elements need to be better used?

Conceptually, there is a subtle difference between serious games and gamification. Serious games are essentially games that do not have as main objective the entertainment of the player, focusing instead on education, training or simulations. The term gamification refers to the use of **game elements** in traditional applications [7]. As this paper is focused on understanding which elements and techniques are used within the context of RE, serious games were not analyzed as part of this context.

This work aims at understanding the use of gamification within RE through a Systematic Literature Review (SLR). The studies were classified and analyzed taking into account the techniques and gamification elements that they used. In addition, it analyzes the tasks and sub-processes of RE that were the scope of these studies, their positive and negative consequences, as well as the challenges they faced.

The rest of this paper is organized as follows. Section 2 presents related work. Section 3 details the methodology applied for conducting the SLR. Section 4 presents the results; and section 5 makes a detailed discussion about the found studies. Conclusions and future work are presented in section 6.

2 Related Work

There are several literature reviews, systematic mappings and experiments that focus on understanding how gamification has been used in several areas. In [9], the authors discuss, for example, whether gamification actually works or not; in that paper, a framework was developed with the objective of verifying the effects of gamification, based on the definition of gamification itself and its motivational factors. Other papers analyzes software engineering at large.

- *R. Cursino, D. Ferreira are with Universidade de Pernambuco and CESAR, Recife, PE, Brazil. E-mails: {rbc, dfs3}@ecomp.poli.br, {rbc, dfs}@cesar.org.br*
- *M. Lencastre, R. Fagundes are with Universidade de Pernambuco, Recife, PE, Brazil. E-mails: mlpm@ecomp.poli.br, roberta.fagundes@upe.br*
- *J. Pimentel is with Universidade Federal Rural de Pernambuco, Recife, PE, Brazil. E-mail: joao.hcpimentel@ufrpe.br*

978-1-5386-5841-3/18/$31.00 ©2018 IEEE
DOI 10.1109/QUATIC.2018.00025

For instance, Pedreira et al. [10] has developed a systematic mapping of the literature with the objective of finding four main characteristics in the works that use gamification: which software processes are addressed, which gamification elements are more commonly used, what types of studies, and where they were published. In that mapping, RE is present with one single study.

In [11], a literature review was developed to know which gamification frameworks or methods exist and what are their main characteristics. That review categorizes existing approaches and a set of eighteen gamified design frameworks according to a nineteen related items. In [12], the authors proposed a gamified requirements inspection process, called Ring-i, that allows stakeholders to verify i* models together, in a playful environment. In [13], the authors analyze the life cycle of serious games, a gaming software whose main objective is not only the entertainment. That paper presents a systematic review observing the software engineering processes for developing serious games in order to find challenges and opportunities that have not yet been explored in this area.

After analyze all these related works, it was possible to observe that there is a lack of literature reviews focused on the use of gamification on Requirements Engineering subprocess and activities. Based on that, the research team decided to explore this opportunity. So that, this SLR aims to contribute to the body of knowledge of RE, describing the state of art of gamification in RE.

3 Research Methodology

The purpose of this systematic review is to better understand how gamification and its elements have been applied in the context of RE. Thus, we expect to answer the following research question: *How has gamification been applied in the context of Requirements Engineering?*

From this overall research question, a set of specific research questions was devised, as listed in Table 1.

TABLE 1
Research questions

Id	Research question
RQ01	What are the most applied gamification techniques and elements in the context of RE?
RQ02	Which RE sub-processes have been targeted in existing RE gamification proposals?
RQ03	What are the consequences of applying gamification elements in the context of RE?
RQ04	What are the benefits, drawbacks, challenges, and lessons learned in applying gamification for RE?

In order to conduct a systematic review addressing these questions, the guidelines proposed by [14], [15] were observed. The following subsections present further details on the planning of this survey: the search strategies and data sources that were adopted, and the inclusion and exclusion criteria for paper selection.

3.1 Search strategy

The search strategy adopted for this review was the automatic search through academic repositories, using a search string validated by experts on Requirements Engineering and on empirical studies. Moreover, an expert on RE gamification was consulted to recommend papers for manual inclusion, resulting in additional 16 papers that were considered for this review.

TABLE 2
Summary of the search strategy

Search attributes	Values
Publication period	January 2007 – June 2017
Digital libraries	Springer Link; ACM Digital Library; IEEE Xplore; ScienceDirect.
Other data sources	RE gamification expert
Target items	Journal papers; Conference papers; Workshop papers; Book chapters.
Language	English
Search applied to	Title; Abstract; Keywords.

Table 2 summarizes the search strategy of this SLR. The digital libraries selected for this study were: Springer Link, ACM Digital Library, IEEE Xplore, and ScienceDirect. The search was performed for documents written in English, published in the last ten years, considering data from title, abstract, and keywords. Not only journal, conference, and workshop papers were searched for, but also book chapters.

Regarding the PICOC (Population, Intervention, Comparison, Outcome, Context) criteria for framing systematic literature reviews [14], this review can be characterized as follows:

- **Population**: peer-reviewed publications on Requirements Engineering;
- **Intervention**: gamification;
- **Comparison**: it does not apply;
- **Outcomes**: the gamification techniques and elements that were most applied for RE; the RE sub-processes that have been targeted in gamified RE approaches; the effect of gamification on RE approaches; the benefits and drawbacks of applying gamification for RE; the challenges and lessons learned when applying gamification for RE;
- **Context**: any context in which Requirements Engineering is applied.

Considering the main terms of the phenomena under investigation, the search string was specified as a conjunction of gamification and RE terms. In order to increase the publication coverage, synonyms and keywords related to these main terms were included in the string. For gamification, the alternative keywords adopted were based on Pedreira et al. [10]. For RE, keywords were taken from the Glossary of Requirements Engineering Terminology of the International Requirements Engineering Board (IREB) [16], as well as from Wiegers and Beatty [17]. The terms included in the final version of our search string, after iterative refinements based on experts' feedback and on pilot searches, are shown in Table 3.

3.2 Inclusion, exclusion, and quality criteria

In order to filter the papers retrieved from the digital libraries, a set of inclusion and exclusion criteria was defined (Table 4). Since the purpose of this review is to better understand gamification applied on RE, we excluded studies

TABLE 3
Search string

Main terms	Alternative terms
Gamification	(gamification OR gamifying OR gamify OR "game-based" OR "game based")
	AND
Requirements Engineering	("requirements engineering" OR "requirements elicitation" OR "requirements identification" OR "requirements analysis" OR "requirements specification" OR "requirements validation" OR "requirements management" OR "requirements verification" OR "requirements negotiation" OR "requirements source" OR "requirements prioritization" OR "requirements documentation" OR "requirements modeling")

that used gamification for educational purposes even when those included RE topics. When duplicated studies were found, only a single copy was included. In the case of multiple iterations of the same proposal, only the study with the most complete description of the proposal was included. If we did not have access to the full text of a particular study through the digital libraries, authors were contacted with a request for a copy.

Besides these general inclusion and exclusion criteria, the papers were filtered based on quality criteria, as recommended by Kitchenham and Charters [14]. Based on existing quality checklists [14], as well as on our research questions, a set of ten questions was defined (Table 5). The threshold for inclusion in this review was the achievement of five points, out of a possible total of ten points.

3.3 Studies selection

The procedure that was executed to select the studies for this review is depicted in Figure 1. A total of 420 studies were retrieved from the automatic search in the digital libraries.

TABLE 4
Inclusion and exclusion criteria

Type	Criteria
Inclusion criteria	– Studies on which gamification is applied to RE – Studies written in English – Studies published between January 2007 and June 2017
Exclusion criteria	– Duplicated studies (only one copy of a duplicated study should be included) – Grey literature – Iterations of the same proposal (only the most complete version of the proposal would be included) – Studies whose full text is not available – Studies on which gamification is applied to learning or teaching, rather than on RE itself – Studies on which gamification is not applied to RE

TABLE 5
Quality checklist

Id	Question	Scoring
QC-01	Is there a clear statement of the goals of the research?	No=0, Partially=0,5, Yes=1
QC-02	Are the research results cleary described?	No=0, Partially=0,5, Yes=1
QC-03	Validity threats and limitations are described?	No=0, Yes=1
QC-04	How relevant is the study, measured by citations number?	Less than five=0, Between five and ten=0,5, More than ten=1
QC-05	The proposal used an existing tool, or developed a new one?	No=0, Yes=1
QC-06	Does the study clearly state the gamification techniques, elements, or tools that were applied?	No=0, Partially=0,5, Yes=1
QC-07	Does the study specify which RE subprocess or activity is targeted?	No=0, Partially=0,5, Yes=1
QC-08	Does the study discriminate which gamification techniques, elements, or tools were applied to each RE subprocess or activity?	No=0, Partially=0,5, Yes=1
QC-09	Does the study present the challenges that were faced or lessons learned?	No=0, Partially=0,5, Yes=1
QC-10	Does the study present the benefits or drawbacks of applying gamification?	No=0, Partially=0,5, Yes=1

230 of them were retrieved from Springer Link, 11 were retrieved from the ACM Digital Library, 176 were retrieved from IEEE Xplore, and 3 were retrieved from ScienceDirect. Moreover, 33 papers were included in this first step due to manual inclusion based on expert recommendation.

After removing papers that were duplicated, as well as applying the inclusion and exclusion criteria based on title and abstract, 38 studies remained for further analysis. Upon reading their introduction and their conclusion, 20 of these 38 studies were excluded from our review. Lastly, after reading the full text of these studies and applying the quality criteria, a total of 8 papers were selected for this SLR (Appendix A).

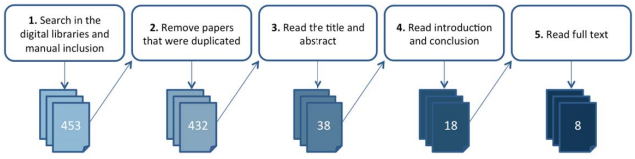

Fig. 1. Study selection procedure

Our manual inclusion of papers was based on recommendations from an expert on the topic of gamification for RE. This expert recommended us a total of 33 papers, from which 21 were already retrieved with the automatic search. From the remaining 16 papers, only one was not excluded based on the inclusion and exclusion criteria, but it failed to satisfy the quality criteria. Thus, in the end, no study was manually included in this review.

4 RESULTS AND ANALYSIS

According to [7], the term "gamification" was used for the first time in 2008 and gained more popularity in 2010. Based on that, it is understandable that few papers were selected in this study, since they deal with the application of gamification in a specific area: the subprocesses of Requirements Engineering. Figure 2 shows the paper's distribution considering the year of their publication. It is possible to observe a concentration of publications in the last 6 years, with an average of 1.6 works per year. Only in 2013 there were no published studies.

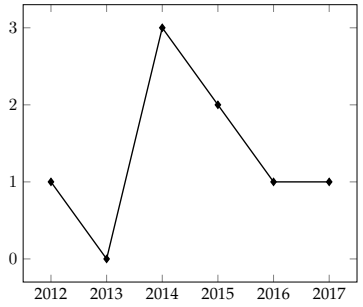

Fig. 2. Distribution of studies per year

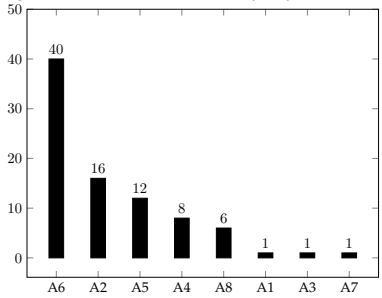

Fig. 3. Number of citations per study

In order to understand which studies have more relevance within the academy, it was observed which are the most cited by other papers. In Figure 3 the involved papers are presented (see Appendix A for details). It is possible to observe that the studies A6 and A2 are the most popular ones, representing 66 % of the citations. A6 is cited by 40 papers; this may be due to the pioneering of this study; it was published in 2012 and explores the use of gamification in the RE subprocesses. A2 has 16 references; it was published in 2014 and contributes not only with a research focused on gamification in ER, but also with the area of crowd-centric Requirements Engineering. Another well-referenced study is the A5, with 12 citations; this study continues the analysis of the research presented in A6. The study A4 has 8 citations and describes the tool cited in paper A2. A8 has 6 quotes. The works A1, A3, A7 has only 1 citation, being the less popular papers.

IEEE Xplore returned the most number of papers, with four papers (50%) included in this review. Both ScienceDirect and Springer Link retrieved two papers, each. None of the papers obtained from the ACM Digital Library were included in this review.

The papers A6, A2, A3 and A8 were published, respectively, at the following conferences: International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES'12); IEEE / ACM 7th International Conference on Utility and Cloud Computing; IEEE 22nd International Requirements Engineering Conference (RE); and International Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ). The studies A1 and A4 were published, respectively, in the IEEE Fifth International Workshop on Empirical Requirements Engineering (EmpiRE) and IEEE 1st International Workshop on Crowd-Based Requirements Engineering (CrowdRE). A5 is available in the Journal Entertainment Computing Volume 5, Issue 4, December 2014 and A7 is a chapter of the book Springer International Publishing's Gamification: Using Game Elements in Serious Contexts.

Next, the resulting primary studies are analyzed, according to the research questions listed in the Table 1.

4.1 RQ01 - What are the most applied gamification techniques and elements in the context of RE?

A total of 25 different gamification elements were applied throughout the studies included in this review. These elements are listed in Figure 4, along with the number of studies that applied each element. Table 6 lists which studies applied each gamification element.

The most applied elements are Points and Leaderboards (seven each) and, to a lesser degree, Badges (applied in three studies). This result is consistent with other works in the literature, which identified that these are among the most common gamification elements [7], [9]. The remaining elements were applied in only one or two studies.

TABLE 6
Mapping of the reviewed studies that apply gamification elements

Gamification elements	Studies
Points; Leaderboards	A1, A2, A4, A5, A6, A7, A8
Badges	A1, A2, A8
Roles; Resources; Group formation; Exploration;	A4, A7
Endorsements	A4, A7
Rewards	A1, A8
Challenges	A8, A8
Metaphor	A3
Ratings; Progression	A5
Profile	A1
Level; Avatar; Activity feeds; Onboarding; Video; Game master; Storytelling; Facial animation; Progress bar; Timer; Liking	A8

Observing the distribution of the number of studies that applied a given gamification element (Figure 5), it can be noticed that most elements were applied in only one or two papers. The distribution of the number of gamification elements applied by a given study (Figure 6) shows that most studies applied two to five elements. Together, these distributions indicate that the repertoire of gamification elements is under-explored in the context of RE.

The clear outlier on Figure 6, which has applied 16 gamification elements, is the paper A8. On this paper, researchers created an online platform on which these elements could

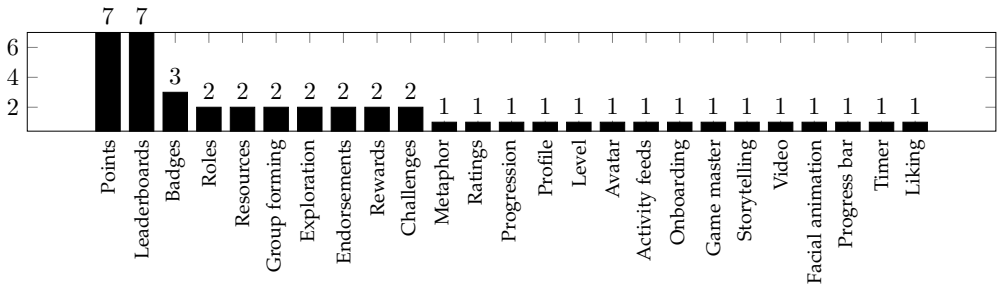

Fig. 4. The number of studies on which each particular gamification element was applied

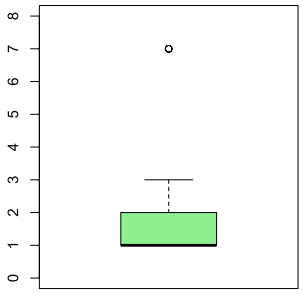

Fig. 5. Distribution of the number of studies that applied a given gamification element

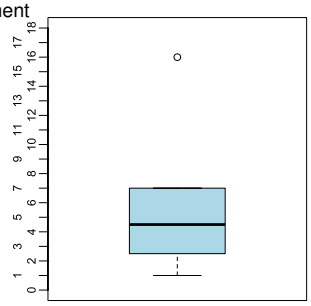

Fig. 6. Distribution of the number of gamification elements applied by a given study

be enabled and disabled individually, aiming to support empirical studies on the effectiveness of each particular element.

Another study, which applies a significant number of gamification elements (seven), is paper A7. Particularly, its selection of elements is related to their contribution to social factors: Points, Leaderboards, Roles, Resources, Group formation, Exploration, and Endorsements.

Papers A3 and A6 apply only one and two gamification elements, respectively. Metaphor was applied by A3; Points and Leaderboards were applied by A6.

4.2 RQ02 - Which RE sub-processes have been targeted in existing RE gamification proposals?

The Requirements Engineering process can be structured as five sub-processes: Elicitation, Negotiation, Prioritization, Validation, and Specification [17]. Table 7 shows the distribution of studies per sub-process.

TABLE 7
Mapping of studies and the sub-process they gamified

Sub-process	Studies
Elicitation	A1, A2, A4, A5, A6, A7, A8
Negotiation	A2, A3, A4, A7
Prioritization	A2, A4, A5, A7
Validation	A1, A4
Specification	A4

The least explored RE sub-processes are Validation (two studies) and Specification (one study). Specification may be the least gamified sub-process because it can be considered the least social of the five sub-processes.

Most studies applied gamification to more than one sub-process. Nonetheless, three studies focused on a single sub-process: A3 on negotiation, A6 on Elicitation, and A8 also on Elicitation.

4.3 RQ03 - What are the consequences of applying gamification elements in the context of RE?

Aiming at understanding what can be expected when applying gamification to RE, we analyzed the consequences reported in the studies. Table 8 shows the mapping between the studies and the consequences that they declared.

The most reported consequence is Engagement (five studies). In particular, studies A2, A5 and A7 report that they applied Points with this specific purpose. Moreover, A6 applied Ratings, in the form of 1-to-5 stars. Lastly, A8 adopt Badges, granted when the user satisfied some criteria.

Increases in Motivation and Communication were declared by a single study each – A2 and A3, respectively.

Studies A5 and A6 apply gamification with the objective of increase the collaboration among stakeholders. They implemented a chat where people could talk to each other and discuss subjects related to the requirements. In addition, stakeholders can add comments on the requirements written by others to collaborate on building a quality artifact and providing complementary visions. The gamification elements that can be associated with these characteristics are feedback and group formation.

A3 reports that the use of a puzzle game metaphor increased communication between participants. In A2, which used Points, Leaderboards, and Badges, motivation was improved. Lastly, no consequence from the application of gamification was explicitly declared in A1 and A4.

TABLE 8
Consequences of gamification in RE

Consequences	Studies
Engagement	A2, A5, A6, A7, A8
Cooperation	A5, A6
Motivation	A2
Communication	A3
Not declared	A1, A4

4.4 RQ04 - What are the benefits, drawbacks, challenges, and lessons learned in applying gamification for RE?

Besides the major consequences summarized in Table 8, the studies reported other potential benefits and drawbacks of gamification. They are summarized in Table 9. The potential benefits are: stakeholders communicated more often between themselves, working as a team towards solving their conflicts (A3); more stakeholders participated more often, and more innovative requirements were elicited (A4, A6, A8); the requirements presented higher quality (A4, A6, A8); the participants were more efficient at prioritizing (A5).

TABLE 9
Potential benefits and drawbacks of applying gamification to RE

Potential Benefits	Studies
Increased stakeholder participation	A4, A6, A8
Higher quality requirements	A4, A6, A8
More innovative requirements	A4, A6, A8
Improved communication	A3
Better prioritization	A5
Potential Drawbacks	**Studies**
Reduction of honesty	A2
Unbalanced prioritization (polarization)	A2
Inhibited creativity	A5
Poor interface	A6
Disinterest in contributing	A7
Shallow requirements	A7

Some potential drawbacks of applying gamification in RE were also identified, as follows: reduction of honesty of the participants, for instance if they act in a way that will improve their points or earn them more badges without actually contributing to the process A2; polarization of prioritization by a subgroup A2; in A5, it is reported that the expected results were not achieved, with participants showing inhibited creativity in idea generation; reduce of stakeholder interest in contributing A7; lack of details in the requirements, resulting in shallow requirements A7.

Some challenges and lessons learned were also identified. According to A7, the gamification elements must suit the participants' profile, otherwise they may not become used in the process. Moreover, when unexperienced stakeholders participate they may provide trivial requirements. Lastly, the lack of a shared vocabulary between participants may be a challenge, specially when technical and non-technical stakeholders interact. In A8, it was identified that longer term execution of a RE sub-process may result in different results than those obtained in its experiments. Finally, A6 mentions the need to improve the visual elements it provides.

5 Discussion

The quality criteria listed in Table 5 were applied in the studies to reach the final primary studies. Figure 7 shows the overall result of the quality assessment according to each criterion.

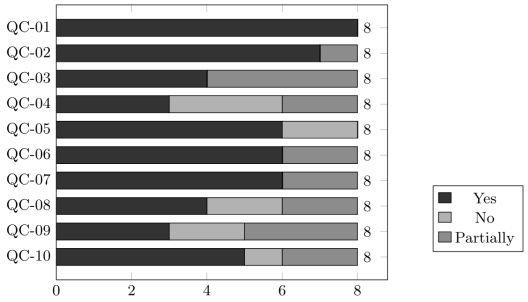

Fig. 7. Overall result of quality criteria

The first criterion (QC01) considers if the objectives of the research are clear. In this case, 100% of the studies described their goals clearly. QC02 seeks to understand whether the results of the research are clearly stated, and in this criterion only the A2 partially describes the results. It was also evaluated if there is limitation, restriction or threat to the validity of the results (QC03). In this criterion, 50% of the studies were evaluated with partial restrictions. Regarding the number of citations of each work, there are 3 works that call attention (A2, A5 and A6) because they are quite referenced. QC05 seeks to evaluate the study that has developed tools. Only 2 papers did not do this (A1 and A2).

QC06 identifies if the techniques and/or gamification elements, used in the paper, were listed; 6 studies clearly listed the gamification elements and tools applied. QC07 tries to understand if the works list the RE subprocesses that are the focus of gamification application; only 2 papers were classified as partially fulfilled. On the relationship between gamification elements and RE subprocesses (QC08), 4 papers explicitly describe how this occurs. QC09 seeks to understand if the studies show difficulties and lessons learned from gamification applications with the RE subprocesses, and only 3 studies report this experience. Finally, QC10 aims at evaluating if the studies show positive and negative points from the gamification applications with the RE subprocesses; only the study A1 does not include this information.

In order to align the researchers' expectations regarding the results obtained, some considerations and assumptions were assumed in this work. In the first step of the selection, made in this SLR, other systematic reviews and mappings related to RE and gamification were excluded, and some were considered only in the related works section (Section 2). As there is a great diversity of studies with gamification related to Software Engineering, only studies that use gamification elements in the RE process or its subprocess (and that met the quality criteria) were selected as primary

studies. Also, it was not the focus of this work to select papers that developed or were related to serious games. In addition, this SLR did not identify the empirical methods used in each work. This identification would have provided further indications regarding the consequences reported by the selected studies.

6 Conclusions and Future Work

The difficulty for engaging users within RE has been a major in some projects. It is estimated that approximately 55% of software system failures occur because problems in requirements elicitation, taking about 82% of the entire development effort to correct these faults [4]. Several studies have also shown that gamification techniques can be used successfully in the context of RE, resulting in some benefits such as an increase in the quality of the requirements, a greater number of requirements and test scenarios elicited, as well as increase of stakeholder engagement [4], [18]. Currently, the use of gamification in industry in general has already been identified as the next generation of marketing tools and user involvement [19]. It is already possible to observe several companies, and mainly startups, that have succeeded by applying gamification techniques within their main activity [9].

Due to the low number of primary studies that were found by this work, it is possible to observe that the gamification within the RE process still has some potential to be explored, mainly within the sub-processes and tasks that involve this area. As an example of this, only 2 studies were found exploring the use of gamification specifically for the requirement specification and requirements validation sub-processes. Another fact that calls attention is the little use of gamification elements in RE other than points and leaderboards. Also, few studies apply a large number of game elements at the same time.

The studies reported that an increase of stakeholders engagement on RE activities was the major consequence of applying gamification. Nonetheless, there are other consequences that could be achieved by applying game elements. Improving the cooperation and communication of teams and stakeholders or increasing the quality of requirements are some examples. It is possible to conclude that there are opportunities to be explored.

As future work, it would be interesting to explore the reasons that lead to a low number of works in gamification within RE, and a lower number still in the subprocesses that do not involve requirements elicitation. Another relevant question that should be asked is about the gamification elements that are not yet explored by the analyzed studies.

Appendix A
Studies Included in the SLR

[A1] Unkelos-Shpigel, Naomi, and Irit Hadar. "Inviting everyone to play: Gamifying collaborative requirements engineering." Empirical Requirements Engineering (EmpiRE), 2015 IEEE Fifth International Workshop on. IEEE, 2015.

[A2] Snijders, Remco, et al. "Crowd-centric requirements engineering." Proceedings of the 2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing. IEEE Computer Society, 2014.

[A3] Pinto-Albuquerque, Maria, and Awais Rashid. "Tackling the requirements jigsaw puzzle." Requirements Engineering Conference (RE), 2014 IEEE 22nd International. IEEE, 2014.

[A4] Snijders, Remco, et al. "REfine: A gamified platform for participatory requirements engineering." Crowd-Based Requirements Engineering (CrowdRE), 2015 IEEE 1st International Workshop on. IEEE, 2015.

[A5] Ribeiro, Claudia, et al. "Gamifying requirement elicitation: Practical implications and outcomes in improving stakeholders collaboration." Entertainment Computing 5.4 (2014): 335-345.

[A6] Fernandes, João, et al. "iThink: A game-based approach towards improving collaboration and participation in requirement elicitation." Procedia Computer Science 15 (2012): 66-77.

[A7] Dalpiaz, Fabiano, et al. "Engaging the crowd of stakeholders in requirements engineering via gamification." Gamification. Springer International Publishing, 2017. 123-135.

[A8] Lombriser, Philipp, et al. "Gamified requirements engineering: model and experimentation." International Working Conference on Requirements Engineering: Foundation for Software Quality. Springer International Publishing, 2016.

References

[1] C. Rupp, M. Simon, and F. Hocker, "Requirements engineering und management," *HMD Praxis der Wirtschaftsinformatik*, vol. 46, no. 3, pp. 94–103, 2009.

[2] S. Group *et al.*, "Chaos summary 2009," *Online report. Accessed June*, vol. 20, 2009.

[3] S. Kujala, M. Kauppinen, L. Lehtola, and T. Kojo, "The role of user involvement in requirements quality and project success," in *Requirements Engineering, 2005. Proceedings. 13th IEEE International Conference on*. IEEE, 2005, pp. 75–84.

[4] J. Fernandes, D. Duarte, C. Ribeiro, C. Farinha, J. M. Pereira, and M. M. da Silva, "ithink: A game-based approach towards improving collaboration and participation in requirement elicitation," *Procedia Computer Science*, vol. 15, pp. 66–77, 2012.

[5] G. Kotonya and I. Sommerville, *Requirements engineering: processes and techniques*. Wiley Publishing, 1998.

[6] K. Pohl, *Requirements engineering: fundamentals, principles, and techniques*. Springer Publishing Company, Incorporated, 2010.

[7] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: defining gamification," in *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*. ACM, 2011, pp. 9–15.

[8] I. Granic, A. Lobel, and R. C. Engels, "The benefits of playing video games." *American Psychologist*, vol. 69, no. 1, p. 66, 2014.

[9] J. Hamari, J. Koivisto, and H. Sarsa, "Does gamification work? – a literature review of empirical studies on gamification," in *2014 47th Hawaii International Conference on System Sciences*, Jan 2014, pp. 3025–3034.

[10] O. Pedreira, F. García, N. Brisaboa, and M. Piattini, "Gamification in software engineering–a systematic mapping," *Information and Software Technology*, vol. 57, pp. 157–168, 2015.

[11] A. Mora, D. Riera, C. Gonzalez, and J. Arnedo-Moreno, "A literature review of gamification design frameworks," in *Games and virtual worlds for serious applications (VS-Games), 2015 7th international conference on*. IEEE, 2015, pp. 1–8.

[12] J. Pimentel, E. Santos, T. Pereira, D. Ferreira, and J. Castro, "A gamified requirements inspection process for goal models," 2018.

[13] S. Aleem, L. F. Capretz, and F. Ahmed, "Game development software engineering process life cycle: a systematic review," *Journal of Software Engineering Research and Development*, vol. 4, no. 1, p. 6, 2016.

[14] S. Keele *et al.*, "Guidelines for performing systematic literature reviews in software engineering," in *Technical report, Ver. 2.3 EBSE Technical Report. EBSE*. sn, 2007.

[15] K. Petersen, R. Feldt, S. Mujtaba, and M. Mattsson, "Systematic mapping studies in software engineering." in *EASE*, vol. 8, 2008, pp. 68–77.

[16] M. Glinz, "A glossary of requirements engineering terminology," *Standard Glossary of the Certified Professional for Requirements Engineering (CPRE) Studies and Exam, Version*, vol. 1.6, 2014.

[17] K. Wiegers and J. Beatty, *Software requirements*. Pearson Education, 2013.

[18] R. Snijders, F. Dalpiaz, S. Brinkkemper, M. Hosseini, R. Ali, and A. Ozum, "Refine: A gamified platform for participatory requirements engineering," in *2015 IEEE 1st International Workshop on Crowd-Based Requirements Engineering (CrowdRE)*, Aug 2015, pp. 1–6.

[19] G. Zichermann and C. Cunningham, *Gamification by design: Implementing game mechanics in web and mobile apps*. " O'Reilly Media, Inc.", 2011.