Gamification for Improving Software Project Management Processes: A Systematic Literature Review

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Abstract. This systematic literature review aims to (a) understand the current state of gamification as a strategy for improving processes associated with software project management and (b) define future gamification in the context of software project management. For these purposes, we identified and analyzed studies based on research interests, including software project management areas explored with gamification, gamification elements used in this context, research methods, and industry type. Our findings indicate a predominance of studies in project management areas related to integration, resources, and scoping. The most commonly reported research method is the solution proposal, and the most commonly used gamification element is the point system. Future research must focus on addressing unexplored project management areas, which can be intervened with gamification as an improvement strategy to facilitate the implementation of good practices that impact the success of software development projects.

Keywords: Gamification · Software project management
Systematic literature review · Software process improvement

1 Introduction

Recently, gamification has been construed as a potential strategy for improving the engagement and motivation of software engineers [1]. It has been studied as an alternative for establishing guides in collaborative work and for improving the interaction among professionals and the transfer of knowledge [A49]. In addition, gamification is being used as a strategy to develop leadership skills and effective communication among the members of the software development team [2].

The nature of software projects makes their management complex and demanding in comparison to the management of other types of non-software-related projects. Software are characterized as intangible products based on changing requirements and are created based on the cognitive processes of a development team. In Addition, the development process is characterized because each project is unique and faces certain management challenges, e.g., dependence on the communication and coordination

rules of the development team, planning and cost/time estimate accuracy, dependence on team members' skills, and generation of innovation and creativity to achieve the objectives of the project [3–5].

As a consequence, the challenges of managing software development projects are related to the factors that impact the quality and success of the projects. Some of these factors are categorized as technical and human factors as well as process, product, or technology factors [6].

In particular, the difficulties associated with the performance of software development team roles, the collaborative work, and the need to integrate and share knowledge and experiences, are some aspects influence the productivity and quality of work and thus the results and success of the project.

This article presents the results of a systematic literature review (SLR) whose objective is to review the state of the art in the application of gamification as an improvement strategy in software project management processes. The results are extended to the context of the gamification elements used in software project management areas and their impact on process improvement based on systematic mapping [7].

The rest of the article is structured as follows. Section 2 presents the supporting theoretical context for the review, Sect. 3 describes the methodology used for the SLR, Sect. 4 presents our results, Sect. 5 discusses these results, and Sect. 6 proposes conclusions and plans for future research.

2 Theory

2.1 Gamification

Gamification is a recent concept that can be defined as the use of game design elements in non-gaming contexts [8]. It seeks to incorporate gaming mechanics and elements in non-gaming environments to improve the engagement, motivation, and performance of users by making their tasks more attractive [1].

There are different contexts wherein gamification is being applied. Some of the most prominent ones are commerce, education, health, organizational systems, work, and innovation. In this way, gamification attempts to positively influence results at a psychological and behavioral user level [9].

Consequently, gamification is applied as a tool to encourage behavioral change and promote desired attitudes in many fields [10]. Furthermore, gamification seeks to use the selected gaming elements to influence changes in user behavior, such as increased engagement, enjoyment and motivation [11].

In software engineering, there are studies that evidence the application of gamification as a supporting alternative in the improvement of their processes, e.g., the proposal of a gamification framework for software process improvement initiatives [12], Gamiware, a gamification platform for the improvement of software processes [A9], and a framework for software engineering gamification [A6].

However, it should be noted that gamification is still a research area with preliminary advances, as reflected in current literature reviews. To date, the literature on gamification has focused mainly on the fields of education, crowdsourcing, and health

[9, 13]; most other fields have received limited attention. However, the interest in incorporating gamification into other domains continues to grow and more varied domains and perspectives are currently being researched [14, 15] [A18].

2.2   Software Project Management

As part of project management, processes focused on the planning, monitoring, and control of the project [16, 17] are commonly identified. At the Project Management Body of Knowledge (PMBOK) [18] level, 10 knowledge areas with associated project management processes are identified. In turn, these processes are framed in groups of initiation, planning, execution, monitoring, control, and closure processes. The project management areas are project integration management, project scope management, project schedule management, project cost management, project quality management, project resource management, project communications management, project risk management, project procurement management, and project stakeholder management.

Within the software engineering context, Sommerville [4] considers software project management as an area for proper management of institutional budget and time constraints.

From this same perspective, Pressman [16] views the management of a software development project as a set of management activities related to the planning, monitoring, and control of people as well as processes and events that occur as software evolve from a preliminary concept to a fully operational implementation.

In the same way, the Project Management Institute (PMI) extends the definition of software project management as "the application of knowledge, skills, tools, and techniques for project activities to meet the project requirements" [3, 18].

3   Materials and Methods

SLR, which is proposed by Kitchenham [19], is a methodology used in the development of this study. It is considered as a rigorous method for reviewing research results. Through SLR, we can identify, evaluate, and interpret all important research studies available for a particular research question, subject area, or phenomenon of interest [19]. For this particular SLR, we used a formal protocol described for software engineering [20].

For the execution of the systematic review, an observation window was defined covering the period between August 2017–December 2017 and February 2018–June 2018.

The objectives of this study are to (a) understand the current state of gamification as a strategy for improving processes associated with software project management and (b) provide suggestions for future research. More specifically, this article focuses on the following research questions:

RQ1:   Which software project management areas are currently being explored using gamification as a strategy for improvement?

RQ2:   Which gamification elements have been used in existing gamification works for software project management?

RQ3:   Which research methods are being applied in this context?
RQ4:   Which types of industries are using gamification in software project management?

The following search chains were used to perform the SLR, derived from the objective of the study, (gamification or gamifying) AND (software project or software project management OR project management OR agile project management).

For these purposes, we selected scientific databases related to computer science, e.g., ACM Digital Library, ScienceDirect (subject: computer science), IEEE Xplore, Scopus, Springer, and Engineering Village.

A total of 1930 studies were obtained, which were reviewed based on the inclusion and exclusion criteria, such as duplicate studies, studies that evidence the use of gamification in software project management, studies wherein the relationship between title, abstract, and keywords and search chain terms is identified, and studies in English, Spanish, or Portuguese.

A more detailed review was performed considering the relationship between title, abstract, and keywords and search chain terms as well as the availability of the information of the selected articles in alignment with the objectives of this SLR.

From the review described above, 49 base studies were extracted and used as the sample for this work. The data extracted from these studies and the results of the SLR are presented in the following section.

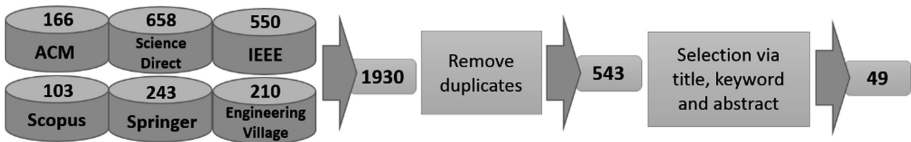A schematic of the literature search and selection procedure is shown in Fig. 1.

Fig. 1. Study selection process.

Before identifying the relevant gamification aspects and determining the current status to define future lines of research, three questions are posed to assess the quality of these studies. The possible answers to these questions will respond whether the study meets, does not meet or partially meets the quality criteria associated with the questions. This assessment will provide information about the degree of gamification applied in software project management areas. The questions and their results are summarized in Table 1.

Finally, the extraction of information from each study was classified in a Microsoft Excel spreadsheet based on the following attributes: title, authors, country, continent, source, year, type of publication, keywords, abstract, research method used, management process, management area, contribution, gamification elements, gamification impact, and type of industry.

Table 1. Primary study assessment results.

Nr.	Questions' assessment	Yes	No	Partially
QA1	Does the study focus on the application of gamification in a software project management area?	38	0	1
QA2	Does the study reflect the impact of gamification on aspects such as communication, engagement, collaboration, and motivation?	19	16	4
QA3	Does the study reflect the impact of gamification on software development team's productivity?	5	32	2

4 Results

With regard to the classification of primary studies according to their software project management areas, a comparative study of international reference models and standards focused on software project management was performed [21]. This study defines an equivalence between the different standards and models by considering the PMBOK model [18] as a reference for software [3]. The models compared against the reference model were CMMI-DEV [22] and SWEBOK [23]. Based on this comparison, we defined the basic management areas for the review. The distribution of the primary studies according to the established management areas is presented in Table 2.

Table 2. Distribution of primary studies according to project management areas.

Management area	Quantity	Frequency (%)	Management area	Quantity	Frequency (%)
Integration	16	32.7	Resource	19	38.8
Scope	9	18.4	Communications	0	0.0
Schedule	0	0.0	Risk	2	4.1
Cost	0	0.0	Procurement	0	0.0
Quality	3	6.1	Stakeholder	0	0.0

The studies were also classified according to the gamification elements used. Although there is not a commonly accepted taxonomy of gamification elements and mechanics [1], we used the elements identified by Pedreira et al. [1] and Muñoz et al. [A46]. Table 3 presents the classification of gamification elements according to the management areas. The table only includes elements whose frequency of use is greater than two.

To analyze how rigorous the research process was in each case, the primary studies have been classified based on their research method according to the proposal of Petersen et al. [24]: (i) validation research, (ii) evaluation research, (iii) solution proposal, (iv) philosophical papers, (v) opinion papers, and (vi) experience papers. Through this classification, we seek to identify the research approach used in the article. Table 4 shows the distribution of primary studies according to the type of research and management areas. Research method categories that did not include

Table 3. Distribution of primary studies according to project management areas and gamification elements.

Gamification element	Management area					Total
	Integration	Resource	Scope	Quality	Risk	
Leaderboards	3	3	4			10
Point system/points	4	3	7	1	2	17
Badges	4	2	4			10
Levels	4	2	2			8
Progress bars			3		1	4
Reward	3	5	4		1	13
Scores			2		1	3
Challenges	1	1	2		1	5
Achievements	2	2				4
Feedback	2	1			1	4
Dashboard	3					3
Ranking	1	1	2			4
Serious game	3	5		2		10
Quests	1	2				3
Avatar	1	1	1			3

Table 4. Distribution of primary studies according to the project management area and research method.

Area	Validation	Solution Proposal	Philosophical	Experience	Total
Integration	[A6]	[A7–A11, A13–A17]	[A18–A21]	[A12]	16
Scope	[A23, A28, A30]	[A22, A24–A27, A29]			9
Quality		[A1]	[A2, A3]		3
Resource	[A34, A36, A37]	[A31–A33, A35, A41–A44, A47, A48]	[A38, A49, A45, A46]	[A39, A40]	19
Risk		[A5, A4]			2
Total	7	29	10	3	49

reference studies (evaluation research and opinion papers) and management areas wherein reference studies were not identified (cost, communications, schedule, procurement, and stakeholder) were eliminated.

The final study selection results were distributed in two types of environments according to the application of their contribution: (a) industry and (b) academics (Table 5).

Table 5. Distribution of selected primary studies by type of industry.

Industry	Quantity	Frequency (%)	Industry	Quantity	Frequency (%)
Academics	16	32.7	Industry/academics	6	12.2
Industry	13	26.5	Unknown	14	28.6

5 Discussion

The findings are expressed in response to the questions posed.

5.1 RQ1: Which Software Project Management Areas Are Currently Being Explored Using Gamification as a Strategy for Improvement?

According to the comparative study of models and international reference standards focused on software project management [21], half of the areas identified as project management areas evidence intervention with a gamification approach (Table 2).

The project resource management area stands out with 38.8%. The studies classified in this area were focused on promoting collaboration among team members, teamwork, leadership, and training.

In addition, the integration management area stands out with 32.7% and the project scope management area stands out with 18.4%. This process is characterized because it is a key process that requires active participation from stakeholders and influences the success of the project [18].

The project quality management area stands out with 6.1%, these studies emphasize on software testing and process improvement. In the case of the project risk management area, the percentage of studies classified was 4.1%, these studies emphasize on gamification strategies at an education or training level.

In conclusion, the software project management areas that explored gamification more as an improvement strategy mainly propose improvement strategies, e.g., (a) teamwork conditions, (b) interaction between stakeholders, and (c) participation of team members in a software development project.

Some of the studies identified are geared toward improvement in the requirement elicitation process. These studies promote the participation and engagement of stakeholders as well as improvements in the interaction and performance of team members.

However, there still remain unexplored management areas, including schedule management, cost management, communications management, procurement management, and stakeholder management.

Software project management is still an area of current research. Gamification as an improvement strategy can contribute to a project's success since it aims to promote collaboration and competitiveness among people, thereby improving their performance [A18].

5.2 RQ2: Which Gamification Elements Have Been Used in Existing Gamification Works for Software Project Management?

Table 3 lists 15 outstanding elements according to their frequency of use. The point system is the predominant element because it influences five management areas. The table of positions, badges, levels, rewards, and serious game also display predominance.

According to Hernández et al. [A49], the table of positions, badges, and point systems improve results and user participation and significantly contribute in the areas of scope management, resources, and integration. The quests and levels facilitate user

motivation and orientation [A31]. On the contrary, the tables of positions facilitate feedback for the adoption of code navigation practices [A36].

With regard to the table of positions [A30], there is evidence of their contribution in meeting the requirements associated with status and power. In addition, challenges are suitable for people who demand curiosity and independence. In other studies, it was considered player types when assigning the gamification elements using Bartle's taxonomy [A5, A6, A9, A26]. However, the use of gamification elements at the business level still requires research and experimentation [A20].

As a result of the use of these gamification elements in software project management areas, a positive impact geared toward improving their processes is observed. In these studies, we observed an improvement in the participation of users in requirement elicitation as well as in collaboration, engagement, motivation, and communication between work team members. There is evidence of the use of gamification for team education or training, to improve productivity, contribute to the generation of a shared context and awareness of distributed teams, or stimulate and motivate the development team in the construction of knowledge.

5.3   RQ3: Which Research Methods Are Being Applied in this Context?

Table 4 presents a classification of the primary studies according to the research method used [24]. The solution proposal type occupies first class, with 59.2% of the primary studies presenting proposals for solving project management problems by implementing gamification strategies. These studies propose a specific tool, framework, method, or model for these purposes, with tools being the type of contribution that stands out the most. This category also includes games, platforms, software, or software prototypes.

The philosophical method (20.4%) involves group studies, e.g., (a) the state of the art of related topics, (b) exploratory studies, (c) literature reviews, or (d) systematic mappings.

The methods research validation (14.3%) and experience (6.1%) refer to other research studies. No related studies were found in the evaluation and opinion research method types.

Considering the result of this classification and assuming that the type of publication that predominates the most is conference, we can be concluded that most studies related to this topic are preliminary investigations that require new proposals for solving problems in this area of knowledge.

5.4   RQ4: Which Types of Industries Are Using Gamification in Software Project Management?

According to the type of contribution defined, in the academic environment, studies are classified at a higher percentage, i.e., 32.7%, compared to 26.5%, which corresponds to studies with contribution to the industry (Table 5). We were not able to classify 28.6% of the studies since the type of the industry in which they contribute is not explicit. On the contrary, six of the works were classified in both categories, industry and academics, due to their contribution.

Of the studies classified in the academic environment, the project resource management area occupies 37.5% of these studies, integration management occupies 43.75%, project risk management occupies 12.5%, and quality management occupies 6.25%.

With regard to the studies classified in the industry, the project management areas that stand out are integration management with 38.46%, scope management with 23.07%, and project resource management with 38.46%, with requirement elicitation being one of the most explored topics.

For the studies classified in the both the industry and academics contexts, 16.66% focus on integration management, 50% focus on scope management, and 33.33% focus on project resource management.

Based on these findings, we can conclude that in academics, the study of project resource management prevails, specifically with topics related to the work team. In addition, regarding the industry, the focus is mainly on project scope management, especially on requirement elicitation.

In summary, there is a growing interest in the implementation of gamification as a process improvement strategy in software project management. The increase in the number of primary studies determines that software project management is an area of research that is susceptible to the delimitation of future work lines.

Gamification has a positive impact on the development of skills, such as communication, participation, engagement, and motivation (QA2).

6   Conclusions and Future Work

In this article, an SLR was performed to characterize the state of the art regarding the application of gamification in software project management. Once the primary studies were selected, they were classified into different categories, which enabled their analysis and discussion based on the trend of the studies according to management areas, type of research, gamification elements, and type of industry.

The results of this SLR reflect the growing use of gamification and suggest it as a support alternative for the improvement of areas related to software project management. In addition, they favor the identification of future lines of work within this context. Some of these lines can be geared toward the following future works:

(a) Analysis of the impact of gamification in software project management areas
(b) Design of solution proposals wherein gamification can be systematically implemented in industrial environments
(c) Design of gamification measurement models that demonstrate the efficiency in their implementation in software development environments
(d) Identification of the relationship of the social and human factors with software development team's productivity.

Appendix: List of All Studies Included Herein

A1.   Soska, A., Mottok, J., Wolff, C.: Pattern Oriented Card Game Development. 1170–1177 (2017).

A2.   Fraser, G.: Gamification of software testing. Proc. - 2017 IEEE/ACM 12th Int. Work. Autom. Softw. Testing, AST 2017. 2–7 (2017).

A3.   Jovanovic, M., Mesquida, A., Mas, A.: Process Improvement with Retrospective Gaming in Agile Software Development. 543, 287–294 (2015).

A4.   Uyaguari, F.U., Intriago, M., Jácome, E.S.: Gamification Proposal for a Software Engineering Risk Management Course. Adv. Intell. Syst. Comput. 353, III–IV (2015).

A5.   Moreta, L.L., Gamboa, A.C., Palacios, M.G.: Implementing a Gamified application for a Risk Management course. 2016 IEEE Ecuador Tech. Chapters Meet. 1–6 (2016).

A6.   García, F., Pedreira, O., Piattini, M., Cerdeira-Pena, A., Penabad, M.: A framework for gamification in software engineering. J. Syst. Softw. 132, 21–40 (2017).

A7.   Sharma, V.S., Kaulgud, V., Duraisamy, P.: A gamification approach for distributed agile delivery. Proc. 5th Int. Work. Games Softw. Eng. - GAS'16. 42–45 (2016).

A8.   Jurado, J.L., Fernandez, A., Collazos, C.A.: Applying gamification in the context of knowledge management. Proc. 15th Int. Conf. Knowl. Technol. Data-driven Bus. - i-KNOW'15. 1, 1–4 (2015).

A9.   Herranz, E., Colomo-Palacios, R., Seco, A. de A.: Gamiware: A Gamification Platform for Software Process Improvement. Commun. Comput. Inf. Sci. 425, 13–24 (2014).

A10. Ašeriškis, D., Damaševičius, R.: Gamification of a Project Management System. Seventh Int. Conf. Adv. Comput. Interact. Gamification. 200–207 (2014).

A11. Sharma, V.S., Kaulgud, V.: Agile workbench: Tying people, process, and tools in distributed agile delivery. Proc. - 11th IEEE Int. Conf. Glob. Softw. Eng. ICGSE 2016. 69–73 (2016).

A12. Sammut, R., Seychell, D., Attard, N.: Gamification of Project Management within a Corporate Environment. Proc. 15th Int. Acad. MindTrek Conf. Envisioning Futur. Media Environ. - MindTrek'11. 9 (2011).

A13. Parizi, R.M.: On the gamification of human-centric traceability tasks in software testing and coding. 2016 IEEE/ACIS 14th Int. Conf. Softw. Eng. Res. Manag. Appl. SERA 2016. 193–200 (2016).

A14. Passos, E.B., Medeiros, D.B., Neto, P.A.S., Clua, E.W.G.: Turning real-world software development into a game. Brazilian Symp. Games Digit. Entertain. SBGAMES. 260–269 (2011).

A15. Maxim, B.R., Kaur, R., Apzynski, C., Edwards, D., Evans, E.: An agile software engineering process improvement game. 2016 IEEE Front. Educ. Conf. 1–4 (2016).

A16. Gasca-hurtado, G.P., Gómez-Alvarez, M.C., Muñoz, M., Mejía, J.: Gamification Proposal for Defect Tracking in Software Development Process Gloria. In: Communications in Computer and Information Science. pp. 212–224 (2016).

A17. Mesquida, A., Jovanovic, M., Mas, A.: Process Improving by Playing: Implementing Best Practices through Business Games. 633, 225–233 (2016).

A18. Pedreira, O., García, F., Brisaboa, N., Piattini, M.: Gamification in software engineering - A systematic mapping. Inf. Softw. Technol. 57, 157–168 (2015).

A19. Souza, M.R.D.A., Veado, L.F., Moreira, R.T., Figueiredo, E.M.L., Costa, H.A.X.: Games for learning: Bridging game-related education methods to software engineering knowledge areas. Proc. - 2017 IEEE/ACM 39th Int. Conf. Softw. Eng. Softw. Eng. Educ. Track, ICSE-SEET 2017. 170–179 (2017).

A20. Olgun, S., Yilmaz, M., Clarke, P.M., O'Connor, R. V.: A Systematic Investigation into the Use of Game Elements in the Context of Software Business Landscapes: A Systematic Literature Review. In: International Conference on Software Process Improvement and Capability Determination. pp. 384–398 (2017).

A21. Kosa, M., Yilmaz, M.: Designing Games for Improving the Software. 1, 303–310 (2015).

A22. Kumar, B.S., Krishnamurthi, I.: Improving User Participation in Requirement Elicitation and Analysis by Applying Gamification Using Architect's Use Case Diagram. 49, 471–482 (2016).

A23. Busetta, P., Kifetew, F.M., Munante, D., Perini, A., Siena, A., Susi, A.: Tool-Supported Collaborative Requirements Prioritisation. Proc. - Int. Comput. Softw. Appl. Conf. 1, 180–189 (2017).

A24. Snijders, R., Dalpiaz, F.: Crowd-Centric Requirements Engineering. 0–1 (2014).

A25. Snijders, R., Dalpiaz, F., Brinkkemper, S., Hosseini, M., Ali, R., Özüm, A.: REfine: A gamified platform for participatory requirements engineering. 1st Int. Work. Crowd-Based Requir. Eng. CrowdRE 2015 - Proc. 1–6 (2015).

A26. Piras, L., Giorgini, P., Mylopoulos, J.: Acceptance Requirements and Their Gamification Solutions. Proc. - 2016 IEEE 24th Int. Requir. Eng. Conf. RE 2016. 365–370 (2016).

A27. Unkelos-Shpigel, N., Hadar, I.: Inviting everyone to play: Gamifying collaborative requirements engineering. 5th Int. Work. Empir. Requir. Eng. Emp. 2015 - Proc. 13–16 (2016).

A28. Ribeiro, C., Farinha, C., Pereira, J., Mira da Silva, M.: Gamifying requirement elicitation: Practical implications and outcomes in improving stakeholders collaboration. Entertain. Comput. 5, 335–345 (2014).

A29. Fernandes, J., Duarte, D., Ribeiro, C., Farinha, C., Pereira, J.M., Da Silva, M.M.: IThink : A game-based approach towards improving collaboration and participation in requirement elicitation. Procedia Comput. Sci. 15, 66–77 (2012).

A30. Lombriser, P., Dalpiaz, F., Lucassen, G., Brinkkemper, S.: Gamified requirements engineering: Model and experimentation. Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics). 9619, 171–187 (2016).

A31. Diniz, G.C., Silva, M.A.G., Gerosa, M.A., Steinmacher, I.: Using gamification to orient and motivate students to contribute to oss projects. Proc. - 2017 IEEE/ACM 10th Int. Work. Coop. Hum. Asp. Softw. Eng. CHASE 2017. 36–42 (2017).

A32. Steffens, F., Marczak, S., Filho, F.F., Treude, C., De Souza, C.R.B.: A preliminary evaluation of a gamification framework to jump start collaboration behavior change. Proc. - 2017 IEEE/ACM 10th Int. Work. Coop. Hum. Asp. Softw. Eng. CHASE 2017. 90–91 (2017).

A33. Hof, S., Kropp, M., Landolt, M.: Use of Gamification to Teach Agile Values and Collaboration. Proc. 2017 ACM Conf. Innov. Technol. Comput. Sci. Educ. - ITiCSE'17. 323–328 (2017).

A34. Prause, C.R., Jarke, M.: Gamification for Enforcing Coding Conventions. Proceeding 10th Jt. Meet. Eur. Softw. Eng. Conf. ACM SIGSOFT Symp. Found. Softw. Eng. (ESEC/FSE 2015). 649–660 (2015).

A35. Sukale, R., Pfaff, M.S.: QuoDocs: Improving developer engagement in software documentation through gamification. Proc. Ext. Abstr. 32nd Annu. ACM Conf. Hum. factors Comput. Syst. - CHI EA'14. 1531–1536 (2014).

A36. Snipes, W., Nair, A.R., Murphy-Hill, E.: Experiences gamifying developer adoption of practices and tools. Companion Proc. 36th Int. Conf. Softw. Eng. - ICSE Companion 2014. 105–114 (2014).

A37. Yilmaz, M., Connor, R.V.O.: A Scrumban integrated gamification approach to guide software process improvement: a Turkish case study. Teh. Vjesn. - Tech. Gaz. 23, 237–245 (2016).

A38. Hernandez, L., Munoz, M., Mejia, J., Pena, A., Rangel, N., Torres, C.: Application of gamification elements in software engineering teamwork [Aplicación de elementos de gamificación en equipos de trabajo en la ingeniería de software]. Iber. Conf. Inf. Syst. Technol. Cist. (2017).

A39. Schafer, U.: Training scrum with gamification: Lessons learned after two teaching periods. IEEE Glob. Eng. Educ. Conf. EDUCON. 754–761 (2017).

A40. Akpolat, B.S., Slany, W.: Enhancing Software Engineering Student Team Engagement in a High-Intensity Extreme Programming Course using Gamification. 149–153.

A41. Butgereit, L.: Gamifying mobile micro-learning for continuing education in a corporate IT environment. 2016 IST-Africa Conf. IST-Africa 2016. 1–7 (2016).

A42. Calderón, A., Ruiz, M., O'Connor, R. V: ProDecAdmin: A Game Scenario Design Tool for Software Project Management Training. In: European Conference on Software Process Improvement. pp. 241–248 (2017).

A43. Calderón, A., Ruiz, M., O'Connor, R. V: Coverage of ISO/IEC 29110 Project Management Process of Basic Profile by a Serious Game. In: European Conference on Software Process Improvement. pp. 111–122 (2017).

A44. Muñoz, M., Hernández, L., Mejia, J., Peña, A., Rangel, N., Torres, C., Sauberer, G.: A Model to Integrate Highly Effective Teams for Software Development. In: European Conference on Software Process Improvement. pp. 613–626 (2017).

A45. Rangel, N., Torres, C., Peña, A., Muñoz, M., Mejia, J., Hernández, L.: Team Members' Interactive Styles Involved in the Software Development Process. In: European Conference on Software Process Improvement. pp. 675–685 (2017).

A46. Muñoz, M., Hernández, L., Mejia, J., Gasca-Hurtado, G.P., Gómez-Alvarez, M.C.: State of the Use of Gamification Elements in Software Development Teams. In: European Conference on Software Process Improvement. pp. 249–258 (2017).

A47. De Melo, A.A., Hinz, M., Scheibel, G., Diacui Medeiros Berkenbrock, C., Gasparini, I., Baldo, F.: Version control system gamification: A proposal to encourage the engagement of developers to collaborate in software projects. Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics). 8531 LNCS, 550–558 (2014).

A48. Calderón, A., Ruiz, M.: Coverage of ISO/IEC 12207 Software Lifecycle Process by a Simulation-Based Serious Game. 155, 59–70 (2016).

A49. Hernández, L., Muñoz, M., Mejia, J., Peña, A.: Gamificación en equipos de trabajo en la ingeniería de software: Una revisión sistemática de la literatura Gamification in software engineering teamworks: A systematic literature review. Presented at the (2016).

References

1. Pedreira, O., García, F., Brisaboa, N., Piattini, M.: Gamification in software engineering - a systematic mapping. Inf. Softw. Technol. **57**, 157–168 (2015). https://doi.org/10.1016/j.infsof.2014.08.007

2. Manrique-Losada, B., Gasca-Hurtado, G.P., Gomez Álvarez, M.C.: Assessment proposal of teaching and learning strategies in software process. Rev. Fac. Ing. 105–114 (2015). https://doi.org/10.17533/udea.redin.n77a13

3. Project Management Institute, IEEE Computer Society. Software extension to the PMBOK® Guide Fifth Edition. Project Management Institute, Inc. (2013)

4. Sommerville, I.: Software Engineering, 10th edn. (2016)

5. Ahmed, A.: Software project management (2012)

6. McConnell, S., Águila Cano, I.M., Bosch, A., et al.: Desarrollo y gestión de proyectos informáticos (1997)

7. Machuca-Villegas, L., Gasca-Hurtado, G.P.: Gamification for improving software project: systematic mapping in project management. In: 2018 13th Iberian Conference on Information Systems and Technologies (CISTI). IEEE (2018)

8. Deterding, S., Dixon, D., Khaled, R., Nacke, L.: From game design elements to gamefulness. Schr. zur soziotechnischen Integr. **3**(15), 2797 (2011). https://doi.org/10.1081/E-ELIS3-120043942

9. Hamari, J., Koivisto, J., Sarsa, H.: Does gamification work? - A literature review of empirical studies on gamification. Proc. Annu. Hawaii Int. Conf. Syst. Sci. 3025–3034 (2014). https://doi.org/10.1109/hicss.2014.377

10. Stieglitz, S., Lattemann, C., Robra-Bissantz, S., et al.: Gamification using game elements in serious contexts (2017)

11. Engedal, J.Ø.: Gamification - a study of motivational affordances. Dept. Comput. Sci. Media Technol. **1**, 81 (2015)

12. Herranz, E., Colomo-palacios, R., Seco A de, A., Sánchez-Gordón, M.-L.: Towards a gamification framework for software process improvement initiatives: construction and validation. J. Univ. Comput. Sci. **22**, 1509–1532 (2016)

13. Hamari, J.: Transforming homo economicus into homo ludens: a field experiment on gamification in a utilitarian peer-to-peer trading service. Electron. Commer. Res. Appl. **12**, 236–245 (2013)

14. Heredia, A., Colombo-Palacios, R., Amescua-Seco, A.: A systematic mapping study on software process education, pp. 7–17 (2015)

15. Darejeh, A., Salim, S.S.: Gamification solutions to enhance software user engagement – a systematic review. Int. J. Hum. Comput. Interact. **7318**(10447318), 1183330 (2016). https://doi.org/10.1080/10447318.2016.1183330

16. Pressman, R.S.: Software engineering a practitioner's approach 7th edn. Roger S. Pressman (2010)

17. Sommerville, I.: Ingenieria del Software - 7a edición. 687 (2005)

18. Project Management Institute: A Guide to the Project Management Body of Knowledge, 5th edn. Project Manager Institude, Pennsylvania (2013)

19. Kitchenham, B., Charters, S.: Guidelines for performing systematic literature reviews in software engineering version 2.3. Eng. **45**, 1051 (2007). https://doi.org/10.1145/1134285.1134500

20. Biolchini, J., Mian, P.G., Candida, A., Natali, C.: Systematic review in software engineering. Eng. **679**, 1–31 (2005). https://doi.org/10.1007/978-3-540-70621-2

21. Clasificación de áreas de gestión de proyectos de acuerdo con los modelos de referencia PMBOK, CMMI-DEV y SWEBOK (2018)

22. CMMI Product Team.: Cmmi for development, version 1.3 (2010)

23. Bourque, P., Fairley, R.E. (Dick): Guide to the software engineering body of knowledge version 3.0 (2014)

24. Petersen, K., Feldt, R., Mujtaba, S., Mattsson, M.: Systematic mapping studies in software engineering. In: 12th International Conference on Evaluation and Assessment in Software Engineering (EASE 2008), pp. 1–10 (2008)