Is gamification a way to a softer software process improvement? A preliminary study of success factors

Eduardo Herranz[1], Ricardo Colomo-Palacios[2]

[1] Universidad Carlos III de Madrid, Computer Science Department
Av. Universidad 30, Leganés, 28911, Madrid, Spain
eduardo.herranz@uc3m.es
[2] Faculty of Computer Sciences, Østfold University College
Postboks 700, 1757 Halden, Norway
ricardo.colomo-palacios@hiof.no

Abstract. People factors and more specifically, motivational factors, are key in software initiatives given the intrinsic importance of people in knowledge intensive industries. Within software engineering knowledge areas, in software process improvement (SPI) initiatives the importance of personnel is also paramount. In this scenario gamification can increase the motivation and motivation of the workforce, and by doing so, rise productivity and performance of personnel. However, although SPI could initially benefit from gamification initiatives, it is needed to study carefully the effects of gamification in SPI arenas. Given that SPI presents its enablers and barriers, it is also true that gamification presents also its own panoply of pro and cons. In this paper, authors show some of the anti-patterns but also the enablers of a set of initiatives conducted in the joint field of SPI and gamification.

Keywords: Software Process Improvement; Gamification; Deployment

1   Introduction

Gamification has been proven to upsurge engagement and motivation in multiple and different non-game contexts such as education, healthcare and marketing, among others (Calderón, Boubeta-Puig, & Ruiz, 2018). Technology and more specifically, software engineering is not out of this move. Gamification started in the marketing arena implementing mechanisms like loyalty cards, competitions, stamp books and reward memberships, yet the escalation of gamification has to do with more affordable technology solutions and the generalization of game culture in society (Deterding, 2012). Now gamification is a way to improve engagement in both educational and professional grounds (Souza, Veado, Moreira, Figueiredo, & Costa, 2018).

There is a wide panoply of Gamification definitions. A generally accepted definition is as follows: gamification is the use of game elements and game-design techniques in non-gaming contexts (Deterding, 2012).

Gamification presents several elements, although an excellent description of game design elements is available in in the works of (Chou, Fuqua, & Yuan, 2015; Deterding, 2012; Werbach & Hunter, 2012), maybe a more succinct description is provided by (Muñoz, Hernández, Mejia, Gasca-Hurtado, & Gómez-Alvarez, 2017). In what follows these elements are listed and described with regards to their use in software environments:

- Leaderboards: are valuable to show the user progress or success compared to the evolution of other users or competitors
- Points systems: are suitable to measure the success in realizing a task.
- Badges: are convenient to recognize personal goals and, consequently, to motivate personnel.
- Levels: are useful to provide trials, adapting difficulty to the scale of levels.
- Progress Bars: are suitable to track the advancement of a given task.
- Rewards: are convenient to make a gift to an individual in recognition of his/her performed work.
- Scores: are valuable to measure a user performance while executing an activity.
- Challenges: are useful to make users apply their knowledge and skills to achieve an activity.
- Achievements: Represent specific goals in a main activity.
- Feedback: is useful to deliver meaningful information messages as clues to develop activities
- Unblocking content: is convenient to unblock activities when users achieve goals.

As stated before, gamification has impacted in software engineering scenarios including previous efforts in SPI (Dorling & McCaffery, 2012; Gómez-Álvarez, Gasca-Hurtado, & Hincapié, 2017; Herranz, Colomo-Palacios, & de Amescua Seco, 2015; Herranz, Colomo–Palacios, de Amescua Seco, & Sánchez-Gordón, 2016; Herranz, Colomo-Palacios, de Amescua Seco, & Yilmaz, 2014; Murat Yilmaz & O'Connor, 2016), personality studies (Mert Yilmaz, Yilmaz, O'Connor, & Clarke, 2016), lifecycle management tools (Üsfekes, Yilmaz, Tuzun, Clarke, & O'Connor, 2017), testing (Fraser, 2017; Parizi, 2016; Rojas & Fraser, 2016), project management (Calderón, Ruiz, & O'Connor, 2017), educational purposes (Bartel & Hagel, 2016; Palacin-Silva, Seffah, & Porras, 2018; Su, 2016; Unkelos-Shpigel, 2016) or general gamification frameworks (Calderón et al., 2018; García, Pedreira, Piattini, Cerdeira-Pena, & Penabad, 2017) naming just some of the more recent and relevant works. Following the recent trend to conduct tertiary studies devoted to several aspects in the software engineering discipline, there are also a good set of works devoted to review gamification in software engineering by means of literature studies e.g. (Hernández, Muñoz, Mejia, & Peña, 2016; Kosa, Yilmaz, O'Connor, & Clarke, 2016; Pedreira, García, Brisaboa, & Piattini, 2015; Souza et al., 2018). However, according to (Pedreira et al., 2015), there is a need to provide empirical evidence of the impact of gamification in activities.

In this paper, authors, after a set of implementations in software industry settings, study traditional barriers of SPI and Gamification to stablish critical success factors on the joint application of SPI and gamification.

The remainder of this paper is structured as follows: Section 2 outlines the proposed gamification framework intended to be implemented in organizations. In Section 3 main lessons learnt are presented with regards to the implementation and adoption of the framework. The final section is devoted to conclude the paper and draw main future work.

2 The framework

In previous works, authors presented several aspects related to the gamification framework designed to introduce gamification in SPI environments and in this chapter, authors introduce main aspects of it. Namely the framework itself and the supporting tool are presented.

2.1 The framework

The complexity of SPI and the intrinsic convolution of gamification leads to the need to develop a specific framework that must entail personnel and organizational aspects and define a set of processes to guide it. As stated before, this framework was presented in previous works (Herranz, Colomo-Palacios, & Amescua-Seco, 2013; Herranz et al., 2014). In the last version of the framework the lean Startup (Build-Measure-Learn) method introduced by Ries (Ries, 2011) was adopted. Figure 1 depicts the phases of the framework that are also explained in what follows:
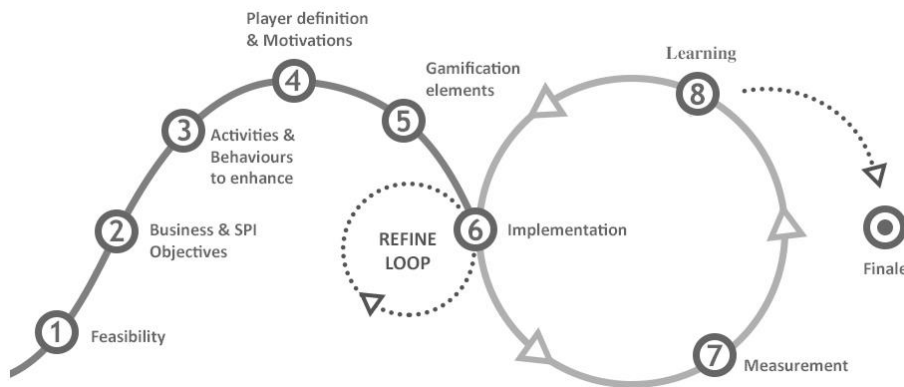
Fig. 1. SPI-Gamification framework: phases

1: FEASIBILITY: The first step is the determination of the viability of the organization in the adoption of the framework. Several aspects are assessed including: availability of necessary resources including time, commitment of top managers and SPI infrastructure.

2: BUSINESS & SPI GOALS: The next step is the definition of business objectives and their associated key performance indicators (KPIs). These aims are defined under the SMART criteria (Doran, 1981) meaning objectives must be Specific, Measurable, Achievable, Relevant and Time-bound. Finally, SPI objectives are defined cascading such objectives from the ones defined for business; for these objectives, metrics must be defined. GQM techniques (Basili, 1992) could be used in order to define metrics related to SPI.

3: ACTIVITIES & BEHAVIOURS TO ENHANCE: In this step, SPI activities and practitioners' behaviors aimed to be enhanced are identified. In order to analyze them, the level of intrinsic motivation of the SPI activity is analyzed by means of the IMI test (Ryan, Koestner, & Deci, 1991). Subsequently, Technical Customer Journey Maps (Richardson, 2010) are employed to analyze the walk-through SPI activity from the practitioner's viewpoint. Lastly, the practitioners' behaviors and attitudes to be enhanced are identified and analyzed.

4: PLAYER DEFINITION & MOTIVATIONS: In this step, the motivational factors (Baddoo & Hall, 2002, 2003) for each of the software professionals groups or SPI roles are analyzed. It is also desirable to identify each group of professionals or SPI roles with some type of players' classification (for instance by means of the taxonomy presented in (Bartle, 1996)) for the gamification proposal.

5: GAMIFICATION ELEMENTS: For each SPI activity aimed to be improved, it is needed to sketch:

1. Dynamics, mechanics and game elements, defined as described in (Werbach & Hunter, 2012) and refined by means of the Octalysis framework (Chou et al., 2015) as explained in previous works (Herranz et al., 2016).
2. Metrics for each of the game elements defined in the previous point.
3. The feedback process system defined to capture and store information on practitioner's activity in real time.
4. Aspects like resistance to change and commitment must be observed and reflected.

6: IMPLEMENTATION: In this step, the gamification proposal defined in STEP 5 is executed and implemented. Nevertheless, before implementing the gamification proposal, all stakeholders must be aware of the gamification project. The aim of this communication is to guarantee all parties understand and adopt the process as a critical aspect in SPI initiatives (J Pries-Heje, Johansen, & Others, 2010). For this implementation, Gamiware, the tool was developed. This tool is explained in the next section.

7: MEASUREMENT: The KPIs of the SPI initiative, motivation metrics and the defined game elements are collected, measured and analyzed.

8: LEARNING: Results are assessed and the main inferences for future iterations are analyzed and documented.

REFINE LOOP: In order to introduce an improvement flavor, taking into account information obtained in the process defined above, the necessary adjustments are made in stages 2-5 in order to improve process and results.

2.2   Gamiware: The tool

Tools are enablers of initiatives. In order to improve the acceptance of the framework, a tool was designed: Gamiware. This is a cloud tool to support the gamification process in an easy and affordable way following the process defined above. Gamiware is designed and implemented to be project and process independent. This tool is able to adapt to any organization and SPI by means of a form-oriented parametric customization. By means of this tools and enabling customization, business objectives, software objectives or SPI objectives are coded. Given the inherent nature of software process as human capital intensive activity (Casado-Lumbreras, Colomo-Palacios, Gomez-Berbis, & Garcia-Crespo, 2009; Colomo-Palacios, Casado-Lumbreras, Misra, & Soto-Acosta, 2014), the identification of software practitioners participating in the gamification process, their tasks and their associated KPIs is mandatory. Moreover, with the aim to improve the alignment of business objectives and SPI activities, it is possible to define the specific contribution of each task to the given business objective and by this mean assess the fulfilment of these objectives. The tool is presented in (Herranz et al., 2015). Figure 2 presents a screen capture of the tool. Gamiware has been developed by research team to support the gamification framework and includes support for different roles, activities and gamification elements:
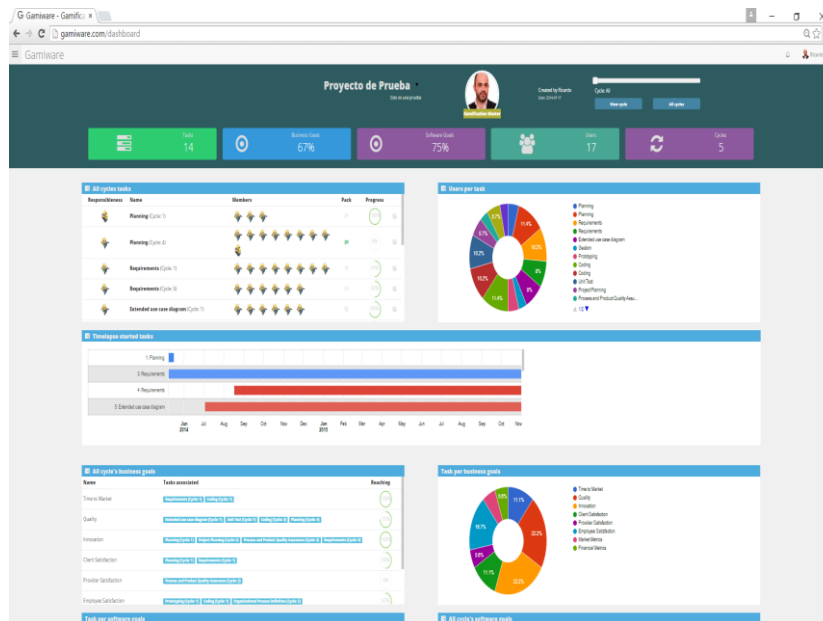

Fig. 2. Gamiware: the backlog

3 Deploying the framework

In this section, main results of the implementation of the framework are introduced. In order to do so, firstly, the sample of the three different case studies is presented, secondly, critical success factors of SPI and gamification initiatives are presented and finally, connecting the two previous points, critical success factors of the implementation of the gamification framework in the SPI settings are presented.

3.1 The sample

Three different companies agreed to implement the framework. Companies were obtained from those who responded positively to a personal invitation sent by the authors to contacts working in Spanish, French and Latin American IT companies. In what follows the three companies are described.

ABC (fictional name) is a small company based in Madrid (Spain) devoted to develop custom-made software solutions at large. Their software development process is based by the ISO/IEC 29110 standard and some of its members hold the CSSLP (Certified Secure Software Lifecycle Professional) certification. The aim of the company in the gamification initiative is the improvement of its process of definition, execution and overall management of software testing. ABC agreed to divide the validation into two different phases: a first phase (1.5 months) in which 6 people are involved in three different types of projects. In the second phase, the gamification process is aimed to extend its works to 2 departments, but its execution would be subject to the results of the first pilot phase. Finally, the framework was deployed and a full cycle of improvement was developed as a result of the execution of the two phases. Although the improvement initiative did not achieve all its goals, it could be considered a partial success reaching some improvements.

DEF (fictional name) is a company founded back on 2012 and devoted to build and market software products mostly based on Big Data technologies. The aim of the company in the gamification initiative is the improvement of cycle times and time to market. In this case study the framework was initially deployed and some personnel embraced the initiative while others simply ignored it. The initiative was cancelled because of this lack of support, although some of the results were initially positive among adopters.

GHI (fictional name) is a Latin American company with branches in several countries like Ecuador, Panama and Peru. With around 15 years in industry, the organization is devoted to develop software solutions on web and mobile platforms, mostly by means of agile approaches and in a near-shoring scenario. The gamification project is aimed to reduce software waste and increase overall quality in the software process. The framework was defined and implemented, although the initiative was cancelled. The reasons for that are twofold: on the one hand and although there was support from company owners and CEO, middle managers were not committed enough with the initiative. On the other hand, by the time when the framework was implemented, there was a time in which a new and important customer started a project with the company and priorities changed.

In the three cases, organizations adopted the framework with the supervision of one member of the research team either on-site or by means of online communication tools. Given that, in the three cases, the research team adopted the methodology presented in previous works (Herranz et al., 2013, 2014), the three organizations fulfilled requisites for gamification deployment.

3.2 Critical success factors in SPI and gamification initiatives

SPI is not a new field. And the concerns of its success factors have been reported in the literature for years. According to a recent review on the topic (Kuhrmann, Diebold, & Münch, 2016), SPI success factors study is increasing interest over the years. Agreeing with (Sulayman, Urquhart, Mendes, & Seidel, 2012), after a qualitative study of several success factors studies identified the following success factors:

1. senior management support
2. staff involvement
3. experience of staff
4. training
5. allocation of resources
6. communication
7. SPI goals
8. organization culture and politics
9. visibility of process and their success
10. process champions
11. reviews
12. clear vision
13. tools
14. reward schemes
15. process ownership

On the other hand, Gamification initiatives present their own critical success factors. In (Herranz et al., 2014), authors define seven success factors for gamification initiatives in SPI by means of a qualitative study. Factors are listed in what follows:

1. Customized proposal
2. Priority on common motivators
3. Viability study
4. Business-users objectives alignment
5. Framework consensus
6. Previous communication
7. Monitoring and feedback

In the next chapter, the combination of these 21 factors are assessed in the three case studies provided, deriving consequences from the set of case studies.

3.3 Critical success factors in the case studies

Table 1 includes the assessment of combined critical success factors. Assessment is performed by means of the Likert scale (1: None; 2: Low; 3: Moderate; 4: High) is

measuring to what extent the given factor was fulfilled in the case study. Further explanation of the values is given in the text that follows:

Table 1. Coverage of success factors by the three case studies

	ABC Case	DEF Case	GHI Case
Senior management support	4	2	3
Staff involvement	3	2	2
Experience of staff	3	3	4
Training	3	2	2
Allocation of resources	3	2	3
Communication	2	2	2
SPI goals	4	4	4
Organization culture and politics	3	2	3
Visibility of process and their success	3	2	3
Process champions	3	2	2
Reviews	2	2	2
Clear vision	3	3	3
Tools	4	4	4
Reward schemes	4	4	4
Customized proposal	4	4	4
Priority on common motivators	4	4	4
Viability study	3	2	2
Business-users objectives	3	2	2
Framework consensus	4	4	4
Previous communication	4	4	4
Monitoring and feedback	2	1	2

According to the values presented in the table, the organization that presents higher values is ABC reaching a sum of 68 points followed by GHI with 63 and finally, DEF with 57 points. These figures are aligned to the gamification results, pointing out the relative success of ABC and the failures in the other two organizations.

With regards to the factors, there are several factors reaching a sum of 12 points, including SPI goals, Tools, Reward schemes, Customized proposal, Priority on common motivators, Framework consensus and Previous communication. Overall, these aspects have to do with the framework already developed and can be controlled in an easier way by researchers. There are also other aspects presenting lower figures, being monitoring and feedback the work factor. The reason behind that could be the overall pale commitment shower by middle managers once the gamification process was started. Other aspects presenting lower values are Communication and Reviews. It is important to note the connection of these factors with Monitoring and feedback.

4   Conclusions and future work

Results show that although there are factors presenting high fulfilment by organizations, lower values in other factors are spoiling overall final results. Then, the fulfilment of some factors (Tools, Reward Schemes, Priority on common motivations…),
is not a guarantee for the success of the initiative as a whole gamification initiative. Given the short sample and the preliminary approach presented in this work, we cannot provide a prioritize success factors, although this prioritization can be seen as a future work.

As stated before, some of the factors presenting higher values, are presenting these high scores because they are directly derived from the framework designed, that include them as part of its deployment. These factors are SPI goals, framework consensus, previous communication, priority on common motivators, reward scheme and customized proposal. However, this set of factors is not enough to ensure the success of the gamification initiative. Those factors that are outside the control of the framework are more complicated to comply with and have a drastic impact on the success of the proposal. In short, those factors that fall on the organization and top managers are the most sensitive and complicated to meet.

For DEF and GHI, "staff involvement" is considered a key factor. Moreover, if "senior commitment" presents moderate values, participants will ignore the initiative, especially if it is not aligned with their own personal objectives ("business-user commitment"). In this scenario, a "process champion" is a key figure to support the gamification initiative. However, this role is normally played by top managers and in the context of urgency in SMEs settings, allocating the time to play the role is not easy threatening the whole gamification process.

There are several factors hard to observe by SMEs:

1. Communication. Although the initial commitment by top managers is high their daily routine is dulling communication.
2. "Reviews" & "Monitoring and feedback". First of all, it should be noted that the feedback received by the participants presents a very low frequency. Multiple investigations indicate that, in order to obtain an adequate performance in a gamification initiative, real-time feedback is mandatory (Chou et al., 2015; Hamari, Koivisto, & Sarsa, 2014; Herranz et al., 2013; Werbach & Hunter, 2012). This fact affects even more the break of the motivation loop (action - feedback - motivation), which has been considered so important to maintain motivation in gamification activities (Marczewski, 2015; Werbach & Hunter, 2012; Zichermann & Linder, 2013).
3. Business-users' objectives. The gamification initiative proposed by the organizations is seen by the participants as an initiative to measure their performance in the SPI tasks involved. That is, it is considered an activity for the control and evaluation of its performance

A correlation is anticipated between the success of the gamification initiative and the success of the SPI initiatives. In both cases it seems difficult to be applied in SMEs settings.

Finally, some viability factors enunciated in the gamification framework have been "relaxed". The aim of this decision is the will to implement the framework. For instance, the lack of sense of urgency is one of the factors indicated in the gamification framework (Herranz et al., 2016). This aspect is also backup by main researchers in the field as one of the main factors to be taken into account then any change management (Kotter, 1997; Jan Pries-Heje, Christiansen, Johansen, & Korsaa, 2007).

As future works, apart from the previous cited initiatives, the analysis of the factors that are taken into account in the feasibility study of the gamification process and its connection with the critical success factors of the initiative is considered.

References

Baddoo, N., & Hall, T. (2002). Motivators of Software Process Improvement: an analysis of practitioners' views. *Journal of Systems and Software*, *62*(2), 85–96. https://doi.org/10.1016/S0164-1212(01)00125-X

Baddoo, N., & Hall, T. (2003). De-motivators for software process improvement: an analysis of practitioners' views. *Journal of Systems and Software*, *66*(1), 23–33. https://doi.org/10.1016/S0164-1212(02)00060-2

Bartel, A., & Hagel, G. (2016). Gamifying the learning of design patterns in software engineering education. In *2016 IEEE Global Engineering Education Conference (EDUCON)* (pp. 74–79). https://doi.org/10.1109/EDUCON.2016.7474534

Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD Research*, *1*(1), 19.

Basili, V. R. (1992). Software modeling and measurement: the Goal/Question/Metric paradigm.

Calderón, A., Boubeta-Puig, J., & Ruiz, M. (2018). MEdit4CEP-Gam: A model-driven approach for user-friendly gamification design, monitoring and code generation in CEP-based systems. *Information and Software Technology*, *95*, 238–264. https://doi.org/10.1016/j.infsof.2017.11.009

Calderón, A., Ruiz, M., & O'Connor, R. V. (2017). ProDecAdmin: A Game Scenario Design Tool for Software Project Management Training. In *Systems, Software and Services Process Improvement* (pp. 241–248). Springer, Cham. https://doi.org/10.1007/978-3-319-64218-5_19

Casado-Lumbreras, C., Colomo-Palacios, R., Gomez-Berbis, J. M., & Garcia-Crespo, A. (2009). Mentoring programmes: a study of the Spanish software industry. *International Journal of Learning and Intellectual Capital*, *6*(3), 293–302.

Chou, Y. K., Fuqua, J., & Yuan, W. (2015). *Actionable Gamification: Beyond Points, Badges, and Leaderboards*. CreateSpace Independent Publishing Platform.

Colomo-Palacios, R., Casado-Lumbreras, C., Misra, S., & Soto-Acosta, P. (2014). Career Abandonment Intentions among Software Workers. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *24*(6), 641–655. https://doi.org/10.1002/hfm.20509

Deterding, S. (2012). Gamification: designing for motivation. *Interactions*, *19*(4), 14–17. https://doi.org/10.1145/2212877.2212883

Doran, G. T. (1981). There'sa SMART way to write management's goals and objectives. *Management Review*, *70*(11), 35–36.

Dorling, A., & McCaffery, F. (2012). The Gamification of SPICE. *Software Process Improvement and Capability Determination*, 295–301.

Fraser, G. (2017). Gamification of Software Testing. In *Proceedings of the 12th International Workshop on Automation of Software Testing* (pp. 2–7). Piscataway, NJ, USA: IEEE Press. https://doi.org/10.1109/AST.2017.20

García, F., Pedreira, O., Piattini, M., Cerdeira-Pena, A., & Penabad, M. (2017). A framework for gamification in software engineering. *Journal of Systems and Software*, *132*, 21–40. https://doi.org/10.1016/j.jss.2017.06.021

Gómez-Álvarez, M. C., Gasca-Hurtado, G. P., & Hincapié, J. A. (2017). Gamification as strategy for software process improvement: A systematic mapping. In *2017 12th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1–7). https://doi.org/10.23919/CISTI.2017.7975773

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? – A Literature Review of Empirical Studies on Gamification. In *2014 47th Hawaii International Conference on System Sciences (HICSS)* (pp. 3025–3034). https://doi.org/10.1109/HICSS.2014.377

Hernández, L., Muñoz, M., Mejia, J., & Peña, A. (2016). Gamification in software engineering teamworks: A systematic literature review. In *2016 International Conference on Software Process Improvement (CIMPS)* (pp. 1–8). https://doi.org/10.1109/CIMPS.2016.7802799

Herranz, E., Colomo-Palacios, R., & Amescua-Seco, A. (2013). Towards a New Approach to Supporting Top Managers in SPI Organizational Change Management. *Procedia Technology*, *9*, 129–138. https://doi.org/10.1016/j.protcy.2013.12.014

Herranz, E., Colomo-Palacios, R., & de Amescua Seco, A. (2015). Gamiware: A Gamification Platform for Software Process Improvement. In R. V. O'Connor, M. U. Akkaya, K. Kemaneci, M. Yilmaz, A. Poth, & R. Messnarz (Eds.), *Systems, Software and Ser-*

vices Process Improvement (pp. 127–139). Springer International Publishing. https://doi.org/10.1007/978-3-319-24647-5_11

Herranz, E., Colomo–Palacios, R., de Amescua Seco, A., & Sánchez-Gordón, M.-L. (2016). Towards a gamification framework for Software Process Improvement initiatives: Construction and Validation. *Journal of Universal Computer Science*, (Improving Social Aspects of the Software Development Process: Games, Gamification And Related Approaches).

Herranz, E., Colomo-Palacios, R., de Amescua Seco, A., & Yilmaz, M. (2014). Gamification as a Disruptive Factor in Software Process Improvement Initiatives. *J-Jucs*, *20*(6), 885–906.

Kosa, M., Yilmaz, M., O'Connor, R., & Clarke, P. (2016). Software engineering education and games: a systematic literature review. *Journal of Universal Computer Science*, *22*(12), 1558–1574.

Kotter, J. P. (1997). Leading change: why transformation efforts fail. *IEEE Engineering Management Review*, *25*(1), 34–40.

Kuhrmann, M., Diebold, P., & Münch, J. (2016). Software process improvement: a systematic mapping study on the state of the art. *PeerJ Computer Science*, *2*, e62. https://doi.org/10.7717/peerj-cs.62

Marczewski, A. (2015). *Even Ninja Monkeys Like to Play*. Gamified UK.

Muñoz, M., Hernández, L., Mejia, J., Gasca-Hurtado, G. P., & Gómez-Alvarez, M. C. (2017). State of the Use of Gamification Elements in Software Development Teams. In *Sys-*

tems, Software and Services Process Improvement (pp. 249–258). Springer, Cham. https://doi.org/10.1007/978-3-319-64218-5_20

Palacin-Silva, M. V., Seffah, A., & Porras, J. (2018). Infusing sustainability into software engineering education: Lessons learned from capstone projects. *Journal of Cleaner Production*, *172*, 4338–4347. https://doi.org/10.1016/j.jclepro.2017.06.078

Parizi, R. M. (2016). On the gamification of human-centric traceability tasks in software testing and coding. In *2016 IEEE 14th International Conference on Software Engineering Research, Management and Applications (SERA)* (pp. 193–200). https://doi.org/10.1109/SERA.2016.7516146

Pedreira, O., García, F., Brisaboa, N., & Piattini, M. (2015). Gamification in software engineering – A systematic mapping. *Information and Software Technology*, *57*, 157–168. https://doi.org/10.1016/j.infsof.2014.08.007

Pries-Heje, J, Johansen, J., & Others. (2010). Spi manifesto. *European System & Software Process Improvement and Innovation*.

Pries-Heje, Jan, Christiansen, M., Johansen, J., & Korsaa, M. (2007). The ImprovAbility TM Model. *Projects and Profits*, *7*(4), 20–29.

Richardson, A. (2010). Using customer journey maps to improve customer experience. *Harvard Business Review*, *15*.

Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation To Create Radically Successful Businesses*. Crown Business.

Rojas, J. M., & Fraser, G. (2016). Code Defenders: A Mutation Testing Game. In *2016 IEEE Ninth International Conference on Software Testing, Verification and Validation Workshops (ICSTW)* (pp. 162–167). https://doi.org/10.1109/ICSTW.2016.43

Ryan, R. M., Koestner, R., & Deci, E. L. (1991). Ego-involved persistence: When free-choice behavior is not intrinsically motivated. *Motivation and Emotion*, *15*(3), 185–205. https://doi.org/10.1007/BF00995170

Souza, M. R. de A., Veado, L., Moreira, R. T., Figueiredo, E., & Costa, H. (2018). A systematic mapping study on game-related methods for software engineering education. *Information and Software Technology*, *95*, 201–218. https://doi.org/10.1016/j.infsof.2017.09.014

Su, C.-H. (2016). The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: a structural equation modeling study. *Multimedia Tools and Applications*, *75*(16), 10013–10036. https://doi.org/10.1007/s11042-015-2799-7

Sulayman, M., Urquhart, C., Mendes, E., & Seidel, S. (2012). Software process improvement success factors for small and medium Web companies: A qualitative study. *Information and Software Technology*, *54*(5), 479–500. https://doi.org/10.1016/j.infsof.2011.12.007

Unkelos-Shpigel, N. (2016). Peel the Onion: Use of Collaborative and Gamified Tools to Enhance Software Engineering Education. In *Advanced Information Systems Engineering Workshops* (pp. 122–128). Springer, Cham. https://doi.org/10.1007/978-3-319-39564-7_13

Üsfekes, Ç., Yilmaz, M., Tuzun, E., Clarke, P. M., & O'Connor, R. V. (2017). Examining Reward Mechanisms for Effective Usage of Application Lifecycle Management Tools. In *Systems, Software and Services Process Improvement* (pp. 259–268). Springer, Cham. https://doi.org/10.1007/978-3-319-64218-5_21

Werbach, K., & Hunter, D. (2012). *For the Win: How Game Thinking Can Revolutionize Your Business*. Philadelphia: Wharton Digital Press.

Yilmaz, Mert, Yilmaz, M., O'Connor, R. V., & Clarke, P. (2016). A Gamification Approach to Improve the Software Development Process by Exploring the Personality of Software Practitioners. In *Software Process Improvement and Capability Determination* (pp. 71–83). Springer, Cham. https://doi.org/10.1007/978-3-319-38980-6_6

Yilmaz, Murat, & O'Connor, R. (2016). A scrumban integrated gamification approach to guide software process improvement: a Turkish case study. *Tehnicki Vjesnik (Technical Gazette)*, *23*(1), 237–245.

Zichermann, G., & Linder, J. (2013). *The Gamification Revolution: How Leaders Leverage Game Mechanics to Crush the Competition*. McGraw Hill Professional.