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Towards a Gamification Framework for Software Process Improvement Initiatives: Construction and Validation

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Abstract: One of the main reasons for failure in Software Process Improvement (SPI) initiatives is the lack of motivation of the professionals involved. Therefore, motivation should be encouraged throughout the software process. Gamification allows us to define mechanisms that motivate people to develop specific tasks. A gamification framework was adapted to the particularities of an organization and software professionals to encourage motivation. Thus, it permitted to facilitate the adoption of SPI improvements and a higher success rate. The objective of this research was to validate the framework presented and increase the actual implementation of gamification in organizations. To achieve this goal, a qualitative research methodology was employed through interviews that involved a total of 29 experts in gamification and SPI. The results of this study confirm the validity of the framework presented, its relevance in the field of SPI and its alignment with the standard practices of gamification implementation within organizations.

Keywords: Gamification, Software Process Improvement, Organizational Change Management
Categories: D.2.7, D.2.9

1 Introduction

Software process improvement (SPI) is seen as the dominant approach to improving software products in software development organizations [Shih and Huang 2010]. SPI has become the primary approach to improving software quality and reliability, employee and customer satisfaction, and return on investment [Mathiassen, Ngwenyama and Aaen 2005]. SPI can be defined as a systematic approach to increasing the efficiency and effectiveness of a software development organization and to enhance software products [Unterkalmsteiner, Gorschek, Islam, Permadi and

Feldt 2012]. In a nutshell, SPI attempts to change how software professionals think and act in their everyday activities [Colomo–Palacios, Casado–Lumbreras, Tovar and Soto–Acosta 2011, Korsaa et al. 2013].

Personnel factors are one of the elements that can have an impact on the productivity of software teams and the effectiveness of the whole software process [Colomo-Palacios, Soto-Acosta, García-Peñalvo and García-Crespo 2012]. More specifically, people can be seen as the main factor in SPI that need to be encouraged and supported in an organization [R. O'Connor and Basri 2012]. Among the personnel factors, motivation is very important for workers in general and, in the case of software workers, it is a one of the most frequently cited causes of software development project failures [Dorling and McCaffery 2012]. There are extensive studies on practitioners' motivation in the software industry in the literature, for example [França, Da Silva, de LC Felix and Carneiro 2014, Verner, Babar, Cerpa, Hall and Beecham 2014] including tertiary studies [Beecham, Baddoo, Hall, Robinson and Sharp 2008]. However, given the complexity of the topic, there are still knowledge gaps to be bridged, both in specific areas in the software engineering arena and in the study of motivational mechanisms.

SPI is also a fertile field of study with regards to the importance of motivation as a soft factor. There are recent and important works devoted to investigating motivation in SPI initiatives [Lee, Shiue and Chen 2016, Niazi 2015]. These studies agree on the importance of counting on new ways to both support implementation and motivate workers.

In recent years, gamification and persuasive technologies have been pointed out as powerful motivational tools in the working spheres. Gamification can be defined as the use of game elements in non-game contexts to modify and influence the behavior of people [Werbach and Hunter 2012]. One of the expected (and documented) consequences of gamification in people's behavior is the increase in motivation and engagement. Given that motivation is an important factor for software practitioners, gamification initiatives are beginning to be implemented in several software fields of which SPI is one of the most fertile areas [Herranz, Colomo-Palacios, de Amescua Seco and Yilmaz 2014]. In recent years several initiatives in the field have been reported regarding the use of gamification in SPICE [Dorling and McCaffery 2012], lead change management initiatives within SPI [Herranz et al. 2014] or present specific tools to support the gamification process [Herranz, Colomo-Palacios and de Amescua Seco 2015]. Following this path, in this paper the authors present a framework designed to support SPI initiatives by means of gamification. This framework is based on the definition of the underlying process and is validated by two groups of experts: gamification and SPI experts. The research is relevant given the lack of a formal gamification process for SPI initiatives that, to the best of the authors´ knowledge, is not explored in the literature.

The remainder of the paper is structured as follows: In Section 2, the methodological framework is introduced. Section 3 describes the research methodology to validate the aforementioned framework. Section 4 explores how the results are going to be analysed. In Section 5, the results of the experts' validation are presented and discussed. Section 6 summarizes the final framework with its modifications. Finally, Section 7 presents the conclusions and implications of the research.

2 The Framework as a starting point

Gamification does not consist of the creation of a holistic game inside the work environment but, rather, the integration of certain game elements in the existent processes of an organization [Werbach and Hunter 2012]. Therefore, the traditional game design frameworks are not valid for this purpose. As a result, over the past few years there has been a large number of frameworks to implement in organizations gamification of a generic nature that have been collected in various research [Mora, Riera, Gonzalez and Arnedo-Moreno 2015]. However, to the best of the authors´ knowledge, there is no existing framework that represents a formal definition of gamification integration within the scope of SPI.

This leads to the definition of a methodological framework for gamification efforts in SPI initiatives that takes into account specific features in terms of organization, processes and personnel. Through gamification, this framework aims to increase the motivation and commitment in the management of SPI organizational change and, thus, facilitate SPI improvements.

A previous version of the framework was presented [Herranz, Colomo-Palacios and Amescua-Seco 2013, Herranz et al. 2014] and launched preliminarily with outstanding results [Herranz et al. 2015]. However, during the research process, this framework underwent a number of changes, aimed at improving efficiency and flexibility in its practical application/in practice, under the proposed methodology Lean Startup (Build-Measure-Learn) [Ries 2011] cycle.

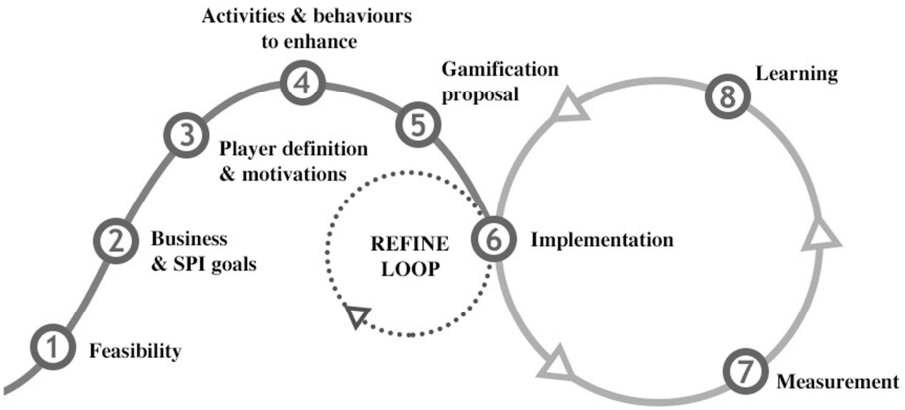

Figure 1: Phases of the SPI-Gamification framework

The resulting framework is described in Figure 1 and the description of the phases is as follows:

PHASE 1: FEASIBILITY: Not every situation is suitable for the application of gamification [Werbach and Hunter 2012]. Therefore, factors such as having the necessary resources, commitment of top managers [Herranz et al. 2013] and an SPI infrastructure to estimate the feasibility of implementing the SPI gamification initiative, need to be analyzed.

PHASE 2: BUSINESS and SPI GOALS: Once the implementation of gamification) is feasible, the business objectives and their associated KPIs are established. These objectives are defined under the SMART criteria [Doran 1981] because the objectives under this criterion specify are the most motivators [Moskowitz and Grant 2009]. Finally, aligned with the business goals, SPI objectives and their respective metrics are defined.

PHASE 3: PLAYER DEFINITION and MOTIVATIONS: Not everyone reacts in the same way to the same stimuli [Werbach and Hunter 2012] and this can be seen in any SPI initiative [Johansen and Pries-Heje 2007]. Therefore, it is necessary to analyse the motivational factors [Baddoo and Hall 2002, 2003] for each of the software professionals groups or SPI roles. It is advisable to identify each group of professionals or SPI roles with a type of player in the [Bartle 1996] players' classification for the gamification proposal as it is considered a good heuristics regarding how people participate in a gamification system [Hägglund 2012].

PHASE 4: ACTIVITIES and BEHAVIOURS TO ENHANCE: In this phase, the SPI activities and the practitioners' behaviors are identified and analyzed. For SPI activities, the level of intrinsic motivation of the SPI activity is analyzed through the IMI test [Ryan, Koestner and Deci 1991] because an activity cannot be gamified if it is not intrinsically motivating to some degree [Andonova 2013, Chou, Fuqua and Yuan 2015, Werbach and Hunter 2012]. Subsequently, the walk-through SPI activity is analyzed from the practitioner's perspective through the Technical Customer Journey Map [Richardson 2010].

Lastly, the practitioners' behaviors to be modified in the related activities are identified and analyzed. The central role of the 'people performing software development tasks' has people's behavior as its integral part [Yilmaz, O'Connor and Clarke 2015].

PHASE 5: GAMIFICATION PROPOSAL: For each SPI activity, it is necessary to define:

1. Dynamic, mechanic and game elements. A preliminary proposal is developed based on the approach of [Werbach and Hunter 2012]. After this first approach, the proposal is complemented, first, using the game elements of the Octalysis framework [Chou et al. 2015] and then, analysing the balance between intrinsic and extrinsic motivations of the developed game mechanics through visual tools provided by Octalysis.
2. Metrics for each of the game elements defined above. It will be necessary to monitor the results of the gamification proposal in order to motivate and engage all professional groups, including senior management [Herranz et al. 2013].
3. The Feedback process through which the user receives information on his/her activity in real time. This will strengthen his/her motivation and will encourage him/her to continue with the proposal [Werbach and Hunter 2012].
4. When defining the gamification proposal, some aspects reflected in models associated with the resistance to change [Kotter 2009] and with the management of commitment must be considered [Conner and Patterson 1982]. In addition, it would be advisable to keep in mind the principles of the SPI Manifesto [Pries-Heje, Johansen and Others 2010].

PHASE 6: IMPLEMENTATION: In this phase, the gamification proposal from the previous phase is executed and implemented at the technological level. However,

before implementing the proposal, it is necessary to communicate this to everyone in the organization in order to ensure all parties understand and agree on the process as a critical aspect in SPI initiatives [Pries-Heje et al. 2010].

For this implementation, an SaaS open source tool (called Gamiware) was developed to support the process in an easy and affordable way. Initial results on its implementation show remarkable success [Herranz et al. 2015].

PHASE 7: MEASUREMENT: In this phase of the gamification framework, the different business metrics (KPIs) of the SPI and the defined game elements are collected and measured. This work is essential in the SPI initiatives in order not to lose focus and to stick to the improvement plan [Pries-Heje et al. 2010].

PHASE 8: LEARNING: With the aim of creating an organization that is continuously learning [Pries-Heje et al. 2010], results are evaluated, the situation is analyzed, and the lessons learned during the implementation process for future iterations of the SPI initiative are considered [Layman 2005].

REFINE LOOP: Finally, depending on the results of the previous phases, the necessary adjustments are made in stages 2-5.

3 Research methodology

This section describes the research methodology that has been carried out to validate the framework presented in the previous section. Therefore, the objectives and research questions that have guided the research approach phases are presented. Next, the process of generating and collecting data is described, emphasizing the nature of the interviews done and the selection criteria of the experts, specifically designed for gamification experts. At all times, the theoretical perspective that underpins the process is reported.

3.1 Goals of the study and research questions

The main objective of this research is to validate the framework presented and to study its feasibility and application in practice. Although empirical studies on implementation of gamification techniques are beginning to emerge [Hamari, Huotari and Tolvanen 2015], they do not have enough consistency [Seaborn and Fels 2015]. In addition, there is a huge gap in the literature on how gamification is implemented in organizations [Huotari and Hamari 2016, Van Roy and Zaman 2015] and, to the best of the authors' knowledge; there is no gamification framework in SPI initiatives. Therefore, to achieve the research objectives, it was necessary, first, to study in a perceptive way how gamification is implemented in organizations and, second, to validate the framework presented from a theoretical and practical perspective, counting, for this whole process, on a large group of experts in the areas of gamification and SPI. Complementarily, this research helps to improve and enrich the framework presented.

In relation to these objectives, the research questions that guided the research are, (1) What is the real implementation process of gamification in organizations? (2) What are the opinions / feelings / attitudes regarding the implementation of gamification in organizations? (3) What are the best practices when implementing

gamification in SPI initiatives?, and finally, (4) Is the framework presented valid for implementing gamification within SPI?.

The first two questions seek to understand the actual phenomenon of implementing gamification in organizations, while the third question aims to implement gamification within the SPI initiatives. Finally, question four aims to validate the framework presented.

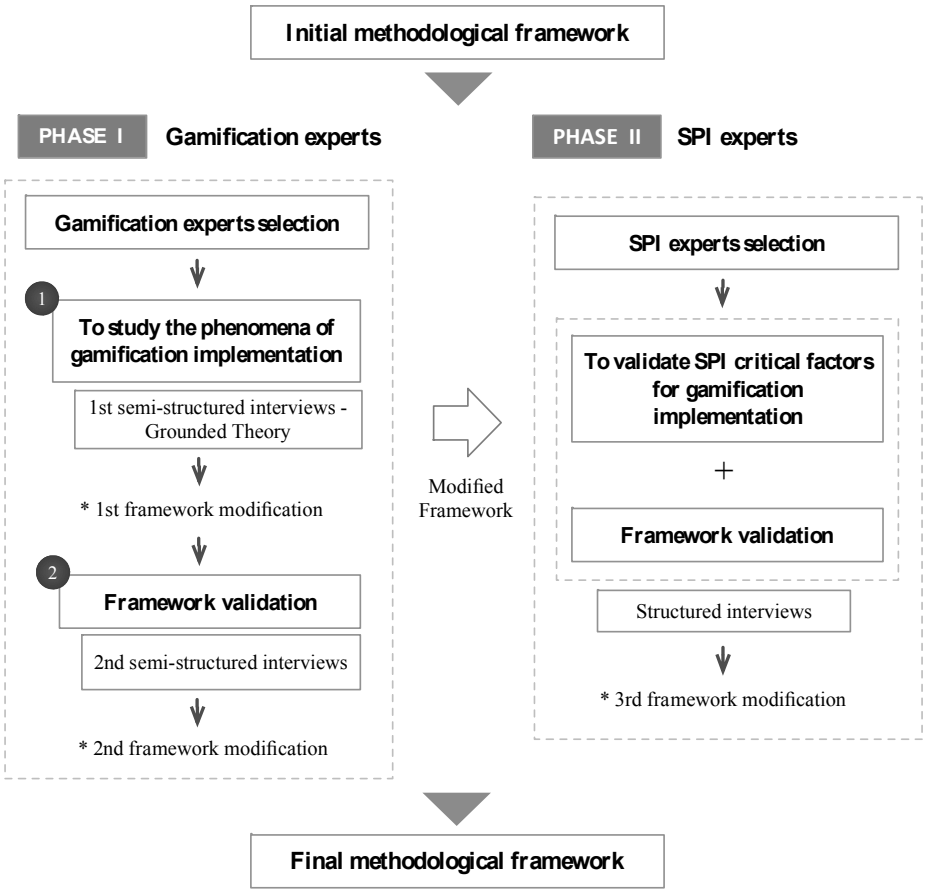

Figure 2: Overview of the research approach

3.2 Research approach

Given that the above questions focus on obtaining a collective understanding of the practitioners' views, an interpretive theoretical perspective was chosen. This perspective leads naturally to qualitative methodology, with methods that involve significant interaction with people directly experiencing the phenomena under investigation. Such qualitative approaches are not uncommon in software process improvement research; qualitative research methods have been applied to investigate

common success factors for SPI programs [Baddoo and Hall 2002, 2003, Coleman and O'Connor 2008].

The data collection consisted of semi-structured interviews with gamification experts and structured interviews with SPI experts, all supplemented with gamification and SPI literature and dissertations of the experts involved. As one of our aims was to study how gamification in practice works instead of whether or not gamification in practice works in a specific way, we had to use an open research method. Therefore, to study the implementation of gamification in organizations, our analysis was based on the grounded theory methodology proposed by [Glaser and Strauss 1967].

The Grounded Theory (GT) approach was chosen because it provides an established, systematic and traceable method for generating conceptual models directly from unstructured and qualitative data sources, such as interview transcripts [Corbin and Strauss 2014]. However, the present study is more focused on creating a detailed description rather than creating a theory and, accordingly, only GT coding process was used to assist the researchers in analysing the present study data [Hoda, Noble and Marshall 2012, R. O'Connor and Basri 2012].

As depicted in Figure 2, the research approach has two main phases, where the input is the framework presented and the output will be the validated framework. In the first phase, semi-structured interviews were conducted with experts in gamification. The GT coding process was used to analyze the data from the interviews and the findings served to make a first improvement on the framework presented. After modifying the framework, another group of experts validated it. In order to do so, another series of semi-structured interviews was carried out, and the analysis crystallized into a second modification of the framework. This modified framework became the input of the second phase. This second phase was conducted with SPI experts. In this case, to validate the modified framework from the SPI perspective and the critical aspects in the implementation of gamification, a set of structured interviews was carried out. The findings from these interviews led to the final change to the framework, which corresponds to the validated final framework presented in Section 6.

3.3 Data collection

The process of data collection consisted of identifying and selecting the experts involved and conducting semi-structured and structured interviews in the order shown in Figure 2. Therefore, in this subsection, the selection criteria used for expert groups will be described in detail, with special emphasis on the criteria used for gamification experts. Finally, the different interviews done will be described.

3.3.1 Recruiting participants

Careful expert selection for these studies is necessary. Therefore, a careful expert selection process must be adopted in order to prevent bias, uncertainty and incompleteness to the maximum extent possible [Freimut, Briand and Vollei 2005].

GAMIFICATION EXPERTS

In the few investigations on gamification where experts have participated, the validity and reliability of the findings have been limited because of disagreement among experts [Herranz et al. 2014], probably due to the fact that this discipline is quite immature [Mekler, Brühlmann, Opwis and Tuch 2013].

To tackle this issue, a specific selection criteria for gamification experts an adaptation of Fehring' proposal [Fehring 1994], was used, giving greater weight to professional experience (see Table 1). In addition, factors such as specific training and participation in conferences as a speaker were included.

Criteria	Scoring
Gamification experience, at least three years' experience and recognized by peers and supervisors as an expert practitioner	04
Teaching experience in gamification at relevant institution(s)	03
PhD in the field of gamification	03
Dissertations in gamification field	02
Master's degree in gamification	02
Publication of article in gamification in reference journals	02
Certificate (specialization) from relevant institution in the field of gamification	01
Published article(s) on gamification with relevant content to the area	01

Table 1: Adaptation of Fehring's (1994) Expert Selection Criteria for gamification

In order for the professionals to be considered gamification experts and selected for participation in the study, a score of 7 in the adapted evaluation rubric (see Table 1) was required.

In this way, a list of 28 potential experts in gamification was compiled; and speakers from the 2015 Gamification World Congress and professionals, who had participated in gamification conferences, were selected. For each of these potential experts, Fehring's criteria was applied (see Table 1), analyzing their LinkedIn profiles and their CVs on their personal websites, when they had one. In this analysis, twenty of these experts obtained a score of seven or higher. They were all contacted by e-mail to participate in the investigation, but only fourteen accepted. To ensure participants were fully informed about the implications of their involvement in the research and to comply with ethical issues, each gamification expert was provided with a research profile. In order to ensure confidentiality, we refer to our participants by numbers, 1–14, rather than by name. Table 2 describes the score each participant obtained, according to the expert selection criteria employed in this study.

Expert	3 years' experience	Teaching experience	Thesis	Dissertation	Master's degree	Published article(s) in reference journal(s)	Certification	Article(s) of relevant content	Score
1	•			•		•		•	9
2	•	•		•				•	10
3	•			•			•	•	8
4	•			•	•	•	•	•	12
5	•	•		•				•	10
6	•	•		•		•		•	12
7	•			•			•	•	8
8	•	•		•			•	•	11
9	•			•	•		•	•	10
10	•			•				•	7
11	•	•	•	•		•		•	15
12	•			•				•	7
13	•	•		•				•	10
14	•	•		•				•	10
n (%)	14 (100)	7 (50)	1 (7.1)	14 (100)	2 (14.2)	4 (28.4)	5 (35.7)	14 (100)	Average (9.93)

Table 2: Characterization of the Experts

As can be seen in Table 2, the experts obtained an average of 9.93, where all the experts have over three years' professional experience but a noticeable lack of academic training in this regard.

SPI EXPERTS

According to [Freimut, Briand and Vollei 2005], ten years' experience was necessary to participate in this experiment in order to assure its validity. SPI practitioners were drawn from both academia and industry. Some potential interviewees from industry were identified based on the researchers' prior working relationship with them. Potential candidates from academia were identified through personal contacts or referrals gained through attendance at software engineering conferences. Twenty experts in SPI were invited by e-mail to participate but fifteen accepted to participate. As with the gamification experts, to ensure participants were fully informed about the implications of their involvement in the research and to comply with ethical issues, each SPI expert was provided with a research profile.

3.3.2 Interviews

For this investigation, experts in gamification and SPI were interviewed using a set of semi-structured and structured interviews in the order depicted in Figure 2.

GAMIFICATION EXPERTS

The overall purpose of the interviews with experts in gamification is to validate in a perceptive way the gamification framework in organizations. In line with the research questions, the different interviews intended to (1) increase knowledge of gamification implementation in organizations, (2) identify areas for improvement in the framework and (3) validate this framework from a gamification perspective.

As a first step, a series of semi-structured interviews were undertaken, with qualitative data analysis utilizing grounded theory coding mechanisms to produce a picture of the gamification implementation phenomena. To do this, the authors conducted an interview round consisting of seven semi-structured interviews with experts 1-7 described in Table 2. The face-to-face interviews were conducted in person during the 2015 Gamification World Congress and lasted 40 minutes on average. These interviews were recorded upon approval of the participants. For the interviews, the researchers prepared an interview guide using based on the methodological framework presented and the literature in the field. The recorded interviews were transcribed and these became the basis for the analysis and framework improvement.

In the first round of interviews, participants did not have access to the framework presented in order not to condition their responses. The interview questions were aimed at understanding how gamification is applied in organizations, so experts were asked to state openly their opinions on this issue. Questions were based on the pillars of the framework and the aspects derived from each of its phases. In addition, the following questions were formulated:

- Could you describe the gamification application process in organizations?
- What are the critical success factors and implementation barriers?
- What is the impact of gamification on the motivation and commitment of the people involved?

After the first round of interviews, the corresponding results were analyzed (see Section 4) and the framework was modified.

In order to validate the framework, we conducted a second round of interviews as a peer-review consisting of seven semi-structured interviews with different experts (experts 8-14, see Table 2) from the previous round to prevent biases. Prior to the interview, each expert received an email with a summary of the framework that had to be read beforehand. In this case, the interviews were online because of the geographical location of the experts, and lasted 30 minutes on average. Similarly, these interviews were recorded with the consent of the participants and transcribed for subsequent analysis. For the interview, researchers were guided by an interview checklist on issues relating to the framework; the following questions were asked:

- What is your first impression?
- Do you think it is valid to be implemented in organizations?
- Do you agree with the proposed relationships and phases?
- Do you think anything is missing from the framework?
- Is anything redundant or overdone in the framework in your opinion?
- Do you have any further comments?

With the results of this second round of interviews, the corresponding analysis was performed and the framework was modified for the second time. This modified framework corresponds to the input of the validation phase with SPI experts and is explained below.

SPI EXPERTS

In this second phase, the purpose of the interviews was to validate as a peer-review the framework in its practical application in SPI initiatives. Additionally, we wanted to validate and identify critical SPI factors to consider when implementing gamification.

In order to do so, we conducted web-based structured interviews, where experts could quickly respond to critical issues of the framework.

The availability of experts is a factor to consider [Benbasat, Goldstein and Mead 1987]. Structured interviews are particularly indicated for descriptive and explanatory objectives like the ones the authors are aiming at in this paper [Runeson and Höst 2008]. Thus, fifteen structured interviews were conducted after the experts had read the latest version of the framework and consisted of both closed and open questions. Closed questions were aimed at validating the principles and hypothesis on which the framework is based in order to obtain a number of metrics. On the other hand, the open questions enabled the experts to freely state their opinions of the framework and suggestions for improvement. The questions asked were about the validity of the framework in its practical application in SPI initiatives, and the success factors and implementation barriers of gamification in SPI were subsequently validated. Specifically, the following questions were asked:

- What elements of the framework do you think could be excluded and/or what elements are missing or left out?
- Do you have any suggestions to improve the framework?
- What are the success factors that should be considered when implementing gamification in SPI initiatives?
- In your opinion, what would be the main barriers to implementing gamification in SPI initiatives?
- Is there any critical factor that has not been addressed in the framework that you consider essential?

4 Analysis

Although data analysis may begin informally during interviews and continue during transcription [O'Connor 2012], in this section we will explain how the formal analysis of the data collected in the interviews was done. This description will be based on the two main phases reflected in Figure 2. In addition, the protocol modifications made to integrate the framework without compromising its validity and reliability will be described.

4.1 Gamification experts interviews

The data collection resulted in a large quantity of unstructured data that subsequently had to be analyzed.

FIRST ROUND INTERVIEWS

We followed the qualitative contents analysis method and adopted the Grounded Theory (GT) [Glaser and Strauss 1967] data coding process to analyze all data collected. The data were coded systematically to ensure that they were analyzed thoroughly. For this process, all the recorded interviews were transcribed, providing us with the full interview text. In this way, we were able to use the interview transcripts directly for the coding of data in the subsequent analysis phase. Moreover, by studying the full interview texts, the repetition of all the elements in the interviews, improved our insight into the data material. Based on the prior experience [Coleman and O'Connor 2008] of the researchers in applying GT coding, we utilized the Atlas.Ti software tool [Muhr 1997].

Three coding techniques, open coding, axial coding and selective coding, proposed by the GT methodology were applied in order to assist researchers in analyzing qualitative data. This process involves the development of the codes, code-categories and the inter-relationship between categories based on the GT process and coding strategy [Glaser and Strauss 1967]. Through open coding, we could deduce candidates for categories, which are relevant issues taken directly from the data material, on which the framework presented is based. Open codes that were found to be conceptually similar or related were grouped under more abstract categories based on their ability to explain the gamification implementation, which is the main unit of analysis [Elo and Kyngäs 2008].

Subsequently, axial coding was used to examine the categories and their interrelationships more closely. In order to do so, we placed related codes into subcategories [Glaser and Strauss 1967]. In this iterative process all the general categories in the open coding process were grouped under higher ordering headings. The purpose of grouping data was to reduce the number of categories by merging similar ones into broader higher categories.

Then the selective coding was performed as a process of selecting the core category, systematically relating it to other categories, validating those relationships and filling in categories that needed further refinement and development [O'Connor 2012]. This process was based on the list of results describing partly the gamification implementation phenomena encountered in the interviews. Finally, the results of this analysis were used as a starting point in the evaluation process modification of the framework as explained in Section 4.3.

SECOND ROUND INTERVIEWS

Similar to other researches, [Ghorbal-Blal 2011, Kristjánsson, Helms and Brinkkemper 2012] , content validation was applied by means of expert evaluation to evaluate and revise the utility of the framework [Burns 1997]. Due to the qualitative nature of the research, two types of data reduction, concept mapping and numeric ranking [Novak and Gowin 1984], were used. A process of data categorization and summarizing supported the data analysis and theme identification. After the interviews were transcribed and reviewed, the data were categorized by construct and interviewee. Concept mapping was used to obtain individual summary statements by

construct. This process was repeated for each expert to arrive at summary statements on each issue of the framework. Also, in the analysis, the summary statements were compared and contrasted with the framework.

Finally, each of the summary statements was analyzed through the process described in Section 4.3, to determine whether or not the framework integrated the results of the analysis.

4.2 SPI experts interviews

Given the qualitative nature of structured interviews, the analysis procedure was the same as in the previous section in the second round of interviews for gamification experts. The only special feature worth mentioning was the existence of three closed questions assessed on a 5-point Likert scale.

4.3 Framework suggestions integration protocol

As we have seen, successive modifications to the framework were performed (see Figure 2) to improve it without compromising its validity and reliability. As a result, verification methods were applied prior to the modification of the framework to ensure that it was internally consistent and that it reflected the views of the practitioners who provided the data for analysis. Four methods of verification were applied to integrate new information into the framework; these were:

1. Checking that the improvement was grounded in the data,
2. Assessing the completeness of the improvement,
3. Comparing the findings from interviews with those from the literature,
4. Subjecting the framework to peer-review.

5 Results and discussion

Based on the analysis, the results of this research have been grouped into three sections. The first corresponds to those relating to the understanding of the gamification implementation phenomenon. The second is related to the validation of the framework from the gamification perspective, while the last section focuses on the validation of the framework, specifically in SPI initiatives, taking into account the proposals for improvement and critical aspects to consider.

5.1 Gamification implementation phenomena

From the qualitative data analysis process, which adopted the GT coding approach, we identified the main and related categories, as shown in Figure 3. During the coding phases, the memoing technique was used. For example, in the open coding phase, some specific gamification techniques, such as competition and collaboration, were identified, and memo notes for each of them were created. Subsequently, in axial coding, resulting from the memo notes, we created a category called “Gamificaction techniques”.

The whole analysis produced 3 categories with 13 subcategories and aims to explain the gamification implementation phenomenon in organizations. The details of the main categories are presented below.

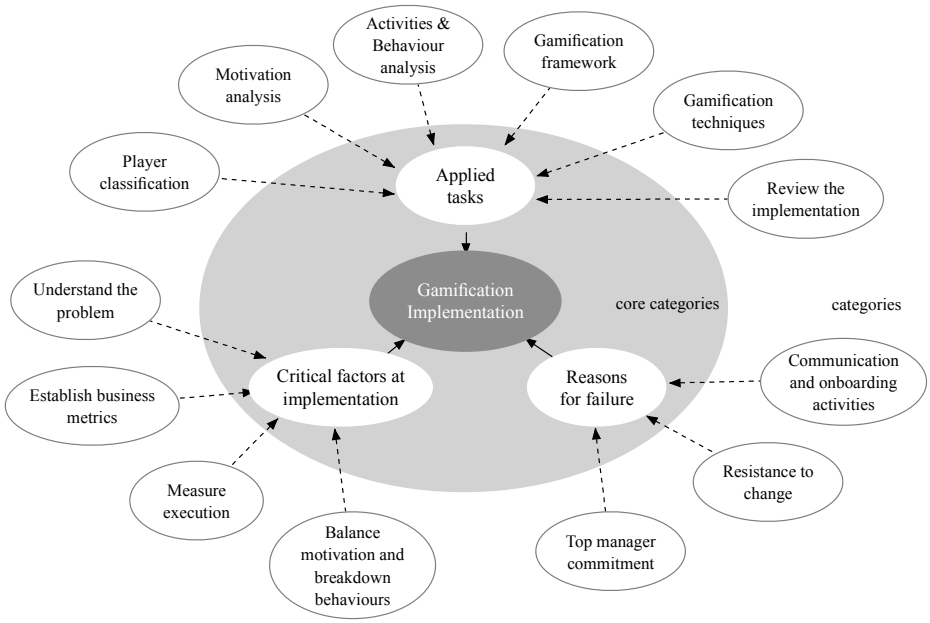

Figure 3: Theme, core categories and categories

APPLIED TASKS

In order to implement gamification in organizations, it is necessary to carry out a series of tasks. The research guideline on semi-structured interviews includes gathering opinions, attitudes and feelings about the main tasks considered in the framework. These interviews helped to increase our understanding of the practical application of these tasks and enhance, where necessary, the framework presented. To this end, all the experts agreed on the need to carry out a motivation analysis and an activities and behavior analysis. As two of the experts stated: “It is not possible to deploy suitable game elements if there is no previous motivation and activities analyses to be performed”. The importance of player classification should be pointed out as reflected in the opinion of expert 5: "A segmentation of the game mechanics must be done. Not everything is for everyone ". However, it is interesting to note that only 15% use a predefined taxonomy, specifically the classification of [Bartle 1996], despite being regarded as a good heuristic [Hägglund 2012]. The remaining 85% prefer a different classification of ad-hoc players for each case. Furthermore, in line with other authors [Chou et al. 2015, Kim 2012, Marczewski 2015], four experts designed the gamification experiences, taking into account the phases of the player journey.

When implementing the tasks, most of the experts used their own gamification framework and the importance of using the proper gamification techniques is relative;

this is the last issue to address. As expert 12 explains: "The establishment of adequate game mechanics play is important, but it is a last step which is conditioned by the necessary prior analysis". Finally, experts 1 and 3 emphasized the need to review the implementation process against the one suggested: "It is necessary to establish a review process given that dissonances between the proposed and implemented technological level are very frequent".

CRITICAL FACTORS AT IMPLEMENTATION

Based on the analysis of the data, the researchers found that in order to succeed in implementing gamification, it is necessary to take into account a series of critical factors. Thus, *understand the problem* was postulated as one of the most important factors, and this was reflected in the opinion of several experts. Once the problem was understood, it was necessary to *establish business metrics*, which subsequently allowed to measure and thus determine the effectiveness of the approach. Interview data analysis revealed that at least eleven experts explicitly mentioned this relationship between *understand the problem, business metrics and* measurement execution.

Finally, four experts pointed out the inability to perform a proper analysis of motivation and behavior if there is no *balance between extrinsic and intrinsic motivation,* while two other experts strongly emphasized the need for *breaking down the behaviors,* allowing to monitor the right elements.

REASONS FOR FAILURE

This category explains the main reasons that can lead to failure in the implementation of gamification. In alignment with some SPI literature [Stelzer and Mellis 1998], the analysis has confirmed that the commitment of top managers is essential. This is illustrated in these interview extracts: "Without the commitment of top managers the necessary resources will not deployed [...] and in the end the proposal will be discarded" and "The top managers' doubts about the gamification initiative will be transferred to the rest of the team". In this respect, the authors have carried out research that propose precisely gamification techniques, which allow to increase the commitment of top managers in SPI initiatives [Herranz et al. 2013].

Another major cause of failure is strong resistance to change within the organization. As one interviewee explained, "The resistance to change inhibits the implementation of any proposal". Regarding this concept, one expert remarked, "infrastructure and organizational culture seriously condition the resistance to change", while another expert commented on the subcategories examined: "Resistance to change will be multiplied if top managers are not committed and do not provide support".

Furthermore, four of the experts vehemently defended the need to establish communication actions prior to the implementation of the proposal. One of the experts said, "communication actions not only transmit information but arouse interest and motivation in the proposal" and the other expert defined the need to encourage a "voluntary process approach to a gamified proposal".

After a review of the results described, we checked whether the concepts reflected in the categories and subcategories above were included in the framework presented. The comparison of these elements, in relation to the different phases and

concepts of the framework, do not reveal significant differences. Moreover, most of the attributes and properties identified can be related to at least one concept or phase of the framework. The comparison between the different source classes can be seen as a form of triangulation, and the lack of significant difference provides a level of confidence in the framework.

Despite consensus among the various sources, there are small details and considerations that, after applying the process described in section 4.3, were integrated into the framework. The "1st modification" column of Table 4 shows a summary of these changes.

5.2 Gamification framework validation

In this section the results of the validation framework are analyzed by both gamification and SPI experts.

5.2.1 Validation from the gamification experts

From the second round of semi-structured interviews described in section 3.3.2, positive remarks about the first impressions of the framework were unanimous among the seven experts consulted. The framework was described as “high quality framework”, “with an important basis” and “having a high academic rigor”. One reviewer stated that the framework was “[…] balanced, not too simple and not too complex”. However, the same expert argued that “It will be necessary to have an expert to guide the implementation process of the framework”.

Regarding the implementation validity of the framework within organizations, four experts thought they were supportive but did not make any further comments. Two of them stated the need for support staff to implement it in an organization. One reviewer stressed the importance of defining clearly the output of each of the phases and of emphasizing the KPIs, since, according to the expert, "[...] these are the areas that the customer is going to adapt."

Regarding the relationships and order of the phases raised, in line with what [Hamari, Koivisto and Sarsa 2014] indicate in other researches, three of the experts noted that they found it more coherent to analyze the activities and behaviors as a previous step to analyzing motivation and the players. In addition, another reviewer suggested the desirability of representing a final state in the definition of the framework that visually indicates the achievement of objectives.

Finally, most of the reviewers suggested aspects to eliminate or add and also made a few recommendations. Thanks to the analysis, these suggestions can be classified under the *aspects to consider* category when implementing gamification in organizations. Thus, as set out in change management models [Kotter 2009], three of the experts noted the need for urgency when implementing gamification to minimize resistance to change. This need for urgency is considered a differentiating factor when estimating the SPI improvement capacity of an organization.

In addition, in line with [Epstein 2013], two of the experts suggested that “the term ‘gamification’ should not be used to avoid the controversy of using game elements in the work environment”. As for the *recommendations on gamification techniques*, two experts recommended changing the name of the phase from "Gamification Proposal" to "Gamification Elements" because it was more familiar

and suitable for the tasks carried out. On the other hand, aligned [Werbach and Hunter 2012], three experts indicated the need to consider the expiration of the game mechanics and activity cycles (motivation-feedback-action) when defining the elements of gamification.

Consistent with the results obtained from the gamification experts, we can assert the validity, at least from the gamification perspective, of the proposed framework when implementing gamification in organizations. However, many of the experts proposed improvements and modifications that were taken into account following the process described in section 4.3. The "2nd modification" column of Table 4 shows a summary of the changes included in the framework.

5.2.2 Validation from SPI experts

With regard to the closed questions of the interviews, responses were coded using the Likert Scale (5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree) and the mean and standard deviations were calculated. The frequencies of each of these responses, along with item's means and standard deviation for each question are reported in Table 3 below.

Questions	SA	A	N	D	SD	Mean	Std Dev
I am familiar with the concept of gamification, some of its most popular techniques and applications	2	6	5	2	0	3.5333	0.9155
The application of gamification can improve the motivation and commitment of people involved in SPI initiatives	5	7	3	0	0	4.1333	0.7432
The proposed gamification framework is relevant/applicable in SPI initiatives	5	9	0	1	0	4.2	0.7746

Table 3: Frequencies and mean ratings for Likert-scale evaluation items

Although the SPI experts' knowledge about gamification is only slightly above average, the results show that 93.3% of the participants agreed that the framework is relevant and applicable to SPI initiatives. In addition, 80% believe that gamification can improve motivation and commitment of the people involved in these initiatives.

In regard to the success factors and barriers in implementing gamification in SPI initiatives, four experts referred to the need for motivation and involvement of the stakeholders to achieve success in the proposal. In line with [Herranz et al. 2013], two other experts noted the need for commitment by top managers, while one expert pointed out that: "I do not think this framework applies to all SPI initiatives. Thus, success factors may be linked to the type of initiative". Having constant feedback was

a factor that was repeated by the four experts. All of these aspects are reflected in the framework presented.

Finally, experts were asked to make suggestions for improvement in order to adapt the framework to SPI initiatives. As a result of the analysis, we identified three main categories. On the one hand, we have the *measurement* category that includes suggestions related to the measurement of staff motivation and, on the other hand, the measurement of objectives through techniques such as GQM [Basili 1992]. Three experts mentioned the need to measure people's motivation during the process. One noted the desirability of "introducing affective computing with biometric signals during activity evaluation".

The second category identified, corresponds to *feasibility tasks* when implementing gamification. Five of the experts stressed the need to consider cultural aspects of the organization as a previous step to implementing the proposal. Moreover, three experts stressed the importance of communication mechanisms that allow to channel the needs and objectives of the proposal as well as constant feedback on the SPI activities that are performed. Finally, the last category corresponds to about a series of recommendations related to *traceability* of the tasks carried out in the framework. One of the experts correctly defines this need, "I suggest to provide a summary of the traceability of the work product phases […] in order to give stakeholders a better understanding" in line with what it is shown in the SPI Manifesto to achieve the commitment of top managers.

Based on the results obtained from the SPI experts, we can confirm the validity of the proposed framework when implementing gamification in SPI initiatives. Additionally, many of the experts' suggestions were considered following the procedure described in paragraph 4.3. The "3rd modification" column of Table 4 shows a summary of the final modifications included in the framework.

6 Validated Framework

The final validated framework corresponds to the version presented in Section 2 together with each of the subsequent modifications made during the validation process. Table 4 summarizes these changes to the framework.

It should be noted that none of the gamification experts consulted explicitly run a feasibility phase prior to implementation. However, the results show that most of their suggestions and contributions are strongly related to aspects that are necessary to validate before implementing the proposal. Therefore, it was decided to maintain the Feasibility phase as a starting point for successful implementation. Similarly, none of the experts considered the Learning phase in their proposals. However, this phase has been positively considered, so we have decided to keep it since Learning is one of the key principles of the SPI Manifesto's [Pries-Heje et al. 2010], and it is coherent with the lean focus that the execution of the framework supports.

Phase	Framework modifications		
	1st modification	2nd modification	3rd modification
General to the framework		• Add a new final phase	• To improve the traceability of the actions
1. Feasibility		• "Need sense of urgency" as feasibility factor	• "Organizational cultural aspects" and "existence of communication channel" as feasibility factor
2. Business and SPI Goals			• To use GQM technique for software metrics
3. Player Definition and Motivations	• More flexibility in player definition. Accept ad-hoc taxonomies	• Interchange the order of phases 3 and 4	• To establish some relevant metrics for motivation
4. Activities and Behaviors to Enhance	• Break down behaviors into their minimum units		
5. Gamification Proposal	• Take into account the phases of a player journey	• Consider the expiration and the activity cycle	
6. Implementation		• Eliminate/not mention the term 'gamification' in the communication activities	
7. Measurement			• Include the assessment of the motivation metrics
Refine Loop	• Detect dissonances between proposal and technical implementation		

Table 4: Summary of the subsequent modifications of the framework

7 Concluding remarks

From the findings of the investigation, it can be stated that the validity of the gamification framework presented the principles that sustain it and its relevance and applicability in SPI initiatives. Almost all of the 29 experts consulted through

interviews confirmed these assumptions and provided suggestions and improvements that have been properly evaluated and integrated into the framework. In addition, through the Grounded Theory methodology it was possible to increase the level of knowledge of the gamification implementation phenomenon within organizations, providing in-depth information on the critical factors and the reasons for failure of its implementation in practice. The results, after being rigorously analyzed, confirm the alignment between the gamification implementation process and the methodological process established by the framework.

The research is relevant given the lack of a formal gamification process for SPI initiatives that, to the best of the authors´ knowledge, is not explored in the literature. Therefore, through gamification techniques, the framework validated in this research increases the motivation and commitment of the professionals involved in SPI initiatives, facilitating the adoption of these improvements and increasing their success rate.

The limitations of this research are related to the validity and reliability of qualitative data. To address these limitations, several actions were launched. First, the guidelines of the interviews were reviewed by two experts, who were both gamification and SPI experts. Secondly, we used a specific criteria (see Section 3.3.1) for selecting gamification experts that allowed to identify participants who can be really considered experts. On the other hand, to avoid bias in their responses, different experts participated in the successive phases. Finally, all the data derived from interviews were reviewed by specific analysis methods in addition to being contrasted with the literature.

To confirm the external validity of the framework presented and its practical feasibility, an empirical validation in several kinds of organizations and countries in SPI environments will be conducted. Other future developments include the evaluation of the framework through affective computing techniques with biometric signals during framework activities evaluation.

References

[Andonova 2013] Andonova, Y.: 'Loyalty 3.0: How big data and gamification are revolutionizing customer and employee engagement'; Journal of Marketing Analytics, Vol. 1 (2013), pp. 234–236. http://doi.org/10.1057/jma.2013.19

[Baddoo and Hall 2002] Baddoo, N., Hall, T.: 'Motivators of Software Process Improvement: an analysis of practitioners' views'; Journal of Systems and Software, Vol. 62, No. 2 (2002), pp. 85–96. http://doi.org/10.1016/S0164-1212(01)00125-X

[Baddoo and Hall 2003] Baddoo, N., Hall, T.: 'De-motivators for software process improvement: an analysis of practitioners' views'; Journal of Systems and Software, Vol. 66, No. 1 (2003), pp. 23–33. http://doi.org/10.1016/S0164-1212(02)00060-2

[Bartle 1996] Bartle, R.: 'Hearts, clubs, diamonds, spades: Players who suit MUDs'; Journal of MUD Research, Vol. 1, No. 1 (1996), pp. 1–25.

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

[Beecham, Baddoo, Hall, Robinson and Sharp 2008] Beecham, S., Baddoo, N., Hall, T., Robinson, H., Sharp, H.: 'Motivation in Software Engineering: A systematic literature review'; Information and Software Technology, Vol. 50, No. 9–10 (2008), pp. 860–878. http://doi.org/10.1016/j.infsof.2007.09.004

[Benbasat, Goldstein and Mead 1987] Benbasat, I., Goldstein, D. K., Mead, M.: 'The Case Research Strategy in Studies of Information Systems'; MIS Quarterly, Vol. 11, No. 3 (1987), p. 369. http://doi.org/10.2307/248684

[Burns 1997] Burns, R. B.: 'Introduction to research methods'; Addison Wesley Longman (1997).

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

[Coleman and O'Connor 2008] Coleman, G., O'Connor, R.: 'Investigating software process in practice: A grounded theory perspective'; Journal of Systems and Software, Vol. 81, No. 5 (2008), pp. 772–784. http://doi.org/10.1016/j.jss.2007.07.027

[Colomo-Palacios, Soto-Acosta, García-Peñalvo and García-Crespo 2012] Colomo-Palacios, R., Soto-Acosta, P., García-Peñalvo, F. J., García-Crespo, A.: 'A Study of the Impact of Global Software Development in Packaged Software Release Planning'; Journal of Universal Computer Science, Vol. 18, No. 19 (2012), pp. 2646–2668.

[Colomo–Palacios, Casado–Lumbreras, Tovar and Soto–Acosta 2011] Colomo–Palacios, R., Casado–Lumbreras, C., Tovar, E., Soto–Acosta, P.: 'A step towards human capital management in the software industry based on generic competencies'; International Journal of Strategic Change Management, Vol. 3, No. 4 (2011), pp. 247–259. http://doi.org/10.1504/IJSCM.2011.044938

[Conner and Patterson 1982] Conner, D. R., Patterson, R. W.: 'Building commitment to organizational change'; Training & Development Journal, Vol. 36, No. 4 (1982), pp. 18–30.

[Corbin and Strauss 2014] Corbin, J., Strauss, A.: 'Basics of qualitative research: Techniques and procedures for developing grounded theory'; (4th ed.). SAGE Publications (2014).

[Doran 1981] Doran, G. T.: 'There'sa SMART way to write management's goals and objectives'; Management Review, Vol. 70, No. 11 (1981), pp. 35–36.

[Dorling and McCaffery 2012] Dorling, A., McCaffery, F.: 'The Gamification of SPICE'; In Software Process Improvement and Capability Determination (2012), pp. 295–301. http://doi.org/10.1007/978-3-642-30439-2_35

[Elo and Kyngäs 2008] Elo, S., Kyngäs, H.: 'The qualitative content analysis process'; Journal of Advanced Nursing, Vol. 62, No. 1 (2008), pp. 107–115. http://doi.org/10.1111/j.1365-2648.2007.04569.x

[Epstein 2013] Epstein, Z.: 'Enterprise Gamification for Employee Engagement'; (2013).

[Fehring 1994] Fehring, R. J.: 'The Fehring model'; In Classification of nursing diagnoses: proceedings of the tenth conference of North American Nursing Diagnosis Association. Philadelphia: Lippincott (1994), pp. 55–62.

[França, Da Silva, de LC Felix and Carneiro 2014] França, A. C. C., Da Silva, F. Q. B., de LC Felix, A., Carneiro, D. E. S.: 'Motivation in software engineering industrial practice: A cross-case analysis of two software organisations'; Information and Software Technology, Vol. 56, No. 1 (2014), pp. 79–101. http://doi.org/10.1016/j.infsof.2013.06.006

[Freimut, Briand and Vollei 2005] Freimut, B., Briand, L. C., Vollei, F.: 'Determining inspection cost-effectiveness by combining project data and expert opinion'; IEEE Transactions on Software Engineering, Vol. 31, No. 12 (2005), pp. 1074–1092. http://doi.org/10.1109/TSE.2005.136

[Ghorbal-Blal 2011] Ghorbal-Blal, I.: 'The role of middle management in the execution of expansion strategies: The case of developers' selection of hotel projects'; International Journal of Hospitality Management, Vol. 30, No. 2 (2011), pp. 272–282. http://doi.org/10.1016/j.ijhm.2010.09.007

[Glaser and Strauss 1967] Glaser, B., Strauss, A.: 'The discovery grounded theory: strategies for qualitative inquiry'; Aldin, Chicago (1967).

[Hägglund 2012] Hägglund, P.: 'Taking gamification to the next level'; Umeå University, Department of Computing Science (2012).

[Hamari, Huotari and Tolvanen 2015] Hamari, J., Huotari, K., Tolvanen, J.: 'GAMIFICATION AND ECONOMICS 5'; The Gameful World: Approaches, Issues, Applications (2015), p. 139.

[Hamari, Koivisto and Sarsa 2014] Hamari, J., Koivisto, J., Sarsa, H.: 'Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification'; In 2014 47th Hawaii International Conference on System Sciences. IEEE (2014), pp. 3025–3034. http://doi.org/10.1109/HICSS.2014.377

[Hernández-López, Colomo-Palacios, Soto-Acosta and Lumberas 2015] Hernández-López, A., Colomo-Palacios, R., Soto-Acosta, P., Lumberas, C. C.: 'Productivity Measurement in Software Engineering: A Study of the Inputs and the Outputs'; International Journal of Information Technologies and Systems Approach (IJITSA), Vol. 8, No. 1 (2015), pp. 46–68. http://doi.org/10.4018/IJITSA.2015010103

[Herranz, Colomo-Palacios and Amescua-Seco 2013] Herranz, E., Colomo-Palacios, R., Amescua-Seco, A.: 'Towards a New Approach to Supporting Top Managers in SPI Organizational Change Management'; Procedia Technology, Vol. 9 (2013), pp. 129–138. http://doi.org/10.1016/j.protcy.2013.12.014

[Herranz, Colomo-Palacios and de Amescua Seco 2015] Herranz, E., Colomo-Palacios, R., de Amescua Seco, A.: 'Gamiware: A Gamification Platform for Software Process Improvement'; In V. R. O'Connor, M. Umay Akkaya, K. Kemaneci, M. Yilmaz, A. Poth & R. Messnarz (Eds.), Systems, Software and Services Process Improvement. Springer International Publishing (2015), pp. 127–139. http://doi.org/10.1007/978-3-319-24647-5_11

[Herranz, Colomo-Palacios, de Amescua Seco and Yilmaz 2014] Herranz, E., Colomo-Palacios, R., de Amescua Seco, A., Yilmaz, M.: 'Gamification as a Disruptive Factor in Software Process Improvement Initiatives'; Journal of Universal Computer Science, Vol. 20, No. 6 (2014), pp. 885–906. Retrieved from http://www.jucs.org/doi?doi=10.3217/jucs-020-06-0885

[Hoda, Noble and Marshall 2012] Hoda, R., Noble, J., Marshall, S.: 'Developing a grounded theory to explain the practices of self-organizing Agile teams'; Empirical Software Engineering, Vol. 17, No. 6 (2012), pp. 609–639. http://doi.org/10.1007/s10664-011-9161-0

[Huotari and Hamari 2016] Huotari, K., Hamari, J.: 'A definition for gamification: anchoring gamification in the service marketing literature'; Electronic Markets (2016), pp. 1–11. http://doi.org/10.1007/s12525-015-0212-z

[Johansen and Pries-Heje 2007] Johansen, J., Pries-Heje, J.: 'Success with Improvement—Requires the Right Roles to Be Enacted—In Symbiosis'; Software Process: Improvement and Practice, Vol. 12, No. 6 (2007), pp. 529–539. http://doi.org/10.1002/spip.348

[Kim 2012] Kim, A. J.: 'The player's journey: designing over time'; Games, Apps & Services That Bring People Together (2012).

[Korsaa et al. 2013] Korsaa, M., Johansen, J., Schweigert, T., Vohwinkel, D., Messnarz, R., Nevalainen, R., Biro, M.: 'The people aspects in modern process improvement management approaches'; Journal of Software: Evolution and Process, Vol. 25, No. 4 (2013), pp. 381–391. http://doi.org/10.1002/smr.570

[Kotter 2009] Kotter, J.: 'Leading change: why transformation efforts fail'; IEEE Engineering Management Review, Vol. 37, No. 3 (2009), pp. 42–48. http://doi.org/10.1109/EMR.2009.5235501

[Kristjánsson, Helms and Brinkkemper 2012] Kristjánsson, B., Helms, R., Brinkkemper, S.: 'Integration by communication: knowledge exchange in global outsourcing of product software development'; Expert Systems (2012), p. n/a–n/a. http://doi.org/10.1111/j.1468-0394.2012.00640.x

[Layman 2005] Layman, B.: 'Implementing an organizational software process improvement program'; IEEE Software Engineering, Vol. 2 (2005), pp. 279–288.

[Lee, Shiue and Chen 2016] Lee, J.-C., Shiue, Y.-C., Chen, C.-Y.: 'Examining the impacts of organizational culture and top management support of knowledge sharing on the success of software process improvement'; Computers in Human Behavior, Vol. 54 (2016), pp. 462–474. http://doi.org/10.1016/j.chb.2015.08.030

[Marczewski 2015] Marczewski, A.: 'Even Ninja Monkeys Like to Play'; (2015).

[Mathiassen, Ngwenyama and Aaen 2005] Mathiassen, L., Ngwenyama, O. K., Aaen, I.: 'Managing Change in Software Process Improvement'; IEEE Software, Vol. 22, No. 6 (2005), pp. 84–91. http://doi.org/10.1109/MS.2005.159

[Mekler, Brühlmann, Opwis and Tuch 2013] Mekler, E. D., Brühlmann, F., Opwis, K., Tuch, A. N.: 'Disassembling gamification: the effects of points and meaning on user motivation and performance'; In CHI'13 Extended Abstracts on Human Factors in Computing Systems (2013), pp. 1137–1142.

[Mora, Riera, Gonzalez and Arnedo-Moreno 2015] Mora, A., Riera, D., Gonzalez, C., Arnedo-Moreno, J.: 'A Literature Review of Gamification Design Frameworks'; In 2015 7th International Conference on Games and Virtual Worlds for Serious Applications (VS-Games). IEEE (2015), pp. 1–8. http://doi.org/10.1109/VS-GAMES.2015.7295760

[Moskowitz and Grant 2009] Moskowitz, G. B., Grant, H.: 'The psychology of goals'; Guilford Press (2009).

[Muhr 1997] Muhr, T.: 'Atlas. ti'; Berlin: Scientific Software Development (1997).

[Niazi 2015] Niazi, M.: 'A comparative study of software process improvement implementation success factors'; Journal of Software: Evolution and Process, Vol. 27, No. 9 (2015), pp. 700–722. http://doi.org/10.1002/smr.1704

[Novak and Gowin 1984] Novak, J. D., Gowin, D. B.: 'Learning how to learn'; Cambridge University Press (1984).

[O'Connor 2012] O'Connor, R.: 'Using grounded theory coding mechanisms to analyze case study and focus group data in the context of software process research'; Research Methodologies, Innovations and Philosophies in Software Systems Engineering and Information Systems (2012), pp. 1627–1645.

[R. O'Connor and Basri 2012] O'Connor, R., Basri, S.: 'The effect of team dynamics on software development process improvement'; International Journal of Human Capital and Information Technology Professionals, Vol. 3, No. 3 (2012), pp. 13–26. http://doi.org/10.4018/jhcitp.2012070102

[Pries-Heje, Johansen and Others 2010] Pries-Heje, J., Johansen, J., Others: 'SPI Manifesto'; European System & Software Process Improvement and Innovation (2010).

[Ries 2011] Ries, E.: 'The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses'; Crown Books (2011).

[Runeson and Höst 2008] Runeson, P., Höst, M.: 'Guidelines for conducting and reporting case study research in software engineering'; Empirical Software Engineering, Vol. 14, No. 2 (2008), pp. 131–164. http://doi.org/10.1007/s10664-008-9102-8

[Ryan, Koestner and Deci 1991] Ryan, R. M., Koestner, R., Deci, E. L.: 'Ego-involved persistence: When free-choice behavior is not intrinsically motivated'; Motivation and Emotion, Vol. 15, No. 3 (1991), pp. 185–205. http://doi.org/10.1007/BF00995170

[Seaborn and Fels 2015] Seaborn, K., Fels, D. I.: 'Gamification in theory and action: A survey'; International Journal of Human-Computer Studies, Vol. 74 (2015), pp. 14–31. http://doi.org/10.1016/j.ijhcs.2014.09.006

[Shih and Huang 2010] Shih, C.-C., Huang, S.-J.: 'Exploring the relationship between organizational culture and software process improvement deployment'; Information & Management, Vol. 47, No. 5-6 (2010), pp. 271–281. http://doi.org/10.1016/j.im.2010.06.001

[Stelzer and Mellis 1998] Stelzer, D., Mellis, W.: 'Success factors of organizational change in software process improvement'; Software Process: Improvement and Practice, Vol. 4, No. 4 (1998), pp. 227–250.

[Unterkalmsteiner, Gorschek, Islam, Permadi and Feldt 2012] Unterkalmsteiner, M., Gorschek, T., Islam, A. K. M. M., Permadi, R. B., Feldt, R.: 'Evaluation and Measurement of Software Process Improvement—A Systematic Literature Review'; IEEE Transactions on Software Engineering, Vol. 38, No. 2 (2012), pp. 398–424. http://doi.org/10.1109/TSE.2011.26

[Van Roy and Zaman 2015] Van Roy, R., Zaman, B.: 'Moving Beyond the Effectiveness of Gamification'; In Gamification Workshop, CHI (2015).

[Verner, Babar, Cerpa, Hall and Beecham 2014] Verner, J. M., Babar, M. A., Cerpa, N., Hall, T., Beecham, S.: 'Factors that motivate software engineering teams: A four country empirical study'; Journal of Systems and Software, Vol. 92 (2014), pp. 115–127. http://doi.org/10.1016/j.jss.2014.01.008

[Werbach and Hunter 2012] Werbach, K., Hunter, D.: 'For the Win: How Game Thinking Can Revolutionize Your Business'; Philadelphia: Wharton Digital Press (2012).

[Yilmaz, O'Connor and Clarke 2015] Yilmaz, M., O'Connor, R. V, Clarke, P.: 'Software Development Roles'; ACM SIGSOFT Software Engineering Notes, Vol. 40, No. 1 (2015), pp. 1–5. http://doi.org/10.1145/2693208.2693239