An Analysis of Gamification Elements for a Solving Proposal of Software Process Improvement Problems

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Abstract: As seen in the specialized literature, during the implementations of a Software Process Improvement (SPI) program, many cases of failure occur, caused on a recurring basis by problems and difficulties in SPI. In view of this, the need to adopt strategies and approaches to support the implementation of such initiatives is noticeable. Thus, the use of gamification in the context addressed can allow us to define mechanisms that drive people's motivation and commitment to the development of tasks in order to stimulate and accelerate the acceptance of an SPI initiative. In this context, this work aims to present strategies for using elements of gamification, present in the Octalysis Framework, regarding the treatment of the problems and difficulties evidenced. The strategies developed must be seen as possible solutions to be used by organizations to assist them when they encounter situations, in which SPI problems occur.

1 INTRODUCTION

Software process improvement (SPI) is seen as the fundamental approach to improving software products in software development organizations (Shih and Huang, 2010), being used to improve the quality and reliability of the software, employee and customer satisfaction and return on investment, among other factors (Gibson et al., 2006; Travassos and Kalinowski, 2009).

For García et al. (2012), the software sector is constantly changing, as innovative technologies are continually developed, new customers and demands arise, competitors enter to compete for market space. With this, the authors point out that an important factor to guarantee the survival of software organizations is the ability to implement improvements in their processes, to meet the growing needs of software.

In this context, studies report cases of failure in improvement initiatives and basically point out a set of critical issues that characterize the organizational environment in which the initiatives are conducted. Among the existing factors are issues related to individuals' attitudes, for example, lack of motivation and resistance to change by members of organizations and lack of support and commitment from top management in the improvement initiative (Baddoo and Hall, 2002; Niazi et al., 2006).

In this sense, it is important that every SPI initiative considers methods and techniques in the proposed processes to facilitate implementation and, thus, minimize the negative effects perceived by those involved in the process (Merriam, 2009).

Given the above, it is noticeable the need to use mechanisms to treat or minimize the problems or difficulties pointed out in the SPI implementations. Thus, a strategy that can help in this problem, consists in the use of elements of gamification, since it encompasses the use of mechanisms and systematic games to solve problems and to motivate and engage a certain audience (Hamari, Koivisto, Sarsa, 2014).

Ribeiro (2018) states that gamification emerges as an emerging phenomenon and with great potential for application in many fields of human activity, since the methodology of games is quite popular, effective in solving problems and is accepted by current generations that grew up with this type of entertainment, that is, because they have been used

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by people for a long time as a form of entertainment, it becomes easier to accept the use of game mechanics applying to a context outside of a virtual game, to engage people to perform day-to-day processes in different areas of knowledge.

For Hamari and Koivisto (2015), gamification in an organizational environment promotes intrinsic changes that cause the individual to participate in the application of the method. Therefore, over and above any reward offered in this type of method, gamification seeks to value the personal factor, be it in the relationship with the team, as well as the valuation of the individual himself in engaging him to achieve his goals.

Some studies were found in the literature regarding the problems of Systematic Review of the Literature (SRL) and the use of Gamification, which highlights the importance of applying this study.

Herranz et al. (2013) present an approach to change management in SPI initiatives, based on the use of gamification techniques to support SPI processes. The authors highlight change management as one of the important areas to be controlled. In this way, they direct greater care to managers, since their actions are essential in improving the software process and their commitment and support are essential to obtain the benefits of a software process. However, the authors present a gamified approach more focused on top management, without addressing other gaps that are perceived during the implementation of the improvement.

In the work of Herranz et al. (2014) a gamification structure was defined, oriented to the needs of the organization and the groups of software professionals involved in an SPI initiative. To establish an adequate gamification structure, the authors emphasized the need to adapt the motivational factors of each of the professional software groups. Although the authors built a gamified structure to assist different groups of professionals, the approach did not specify elements that should be used as possible solutions to the problems that professionals would face, since the structure to be used depends primarily on the initial study of the people who will be involved improvement initiative.

The study by Herranz et al. (2018) aimed to bridge the gap between gamification in SPI and empirical evidence by presenting the implementation of the SPI gamification structure in a real environment. The structure validated in the authors' previous work was adjusted and implemented in a small Spanish software development organization, in a controlled experiment, with a focus on a team competition (experimental group) to validate its effectiveness. The results of the implementation show that the application of the structure does not increase the motivation of the staff in the tasks of SPI, although it contributes to improve their performance. Therefore, the authors point out that the results obtained are a consequence of the use of the competitive mechanics of the game, which may have caused tension among the participants and this fact can reduce motivation and fun.

As can be seen, none of the works presented addresses a strategy with elements of gamification directed to each problem of SPI, as they address the problem with the mechanism of gamification in a more general way to involve the participants. Another point perceived in the works is the absence of a more in-depth description of the mechanics and gamification components that were used, which can make it difficult to replicate the proposal and negatively impact the results of applying the structure in other organizations.

In this context, the present work differs from the others approached in that it presents as a goal a strategy for the use of gamified elements, present in the Octalysis Framework (Chou, 2016), being an author of great importance in the context of gamification, where the greatest contribution that the methodology can offer to society is the opposition to the traditional model of Design Focused on Functionality for Design Focused on the Human Aspect (Vianna et al., 2013).

Thus, in this work, the elements of the framework are used in relation to SPI problems, interrelating the description of use of each element to the context of the problems.

In addition to this introductory section, this paper is structured as follows: Section 2 presents the research methodology, Section 3 presents the problems found in the SRL, Section 4 presents the relationship of the problems with the gamification elements, Section 5 presents the proposal to use the gamification elements to solve the problems, Section 6 presents an evaluative discussion on the information described in this paper, and Section 7 presents the conclusions and future work.

2 RESEARCH METHODOLOGY

The methodology carried out in this work comprises the steps described below.

Initially, the “Identifying SPI problems” step was carried out, where the problems and difficulties were

identified from analyzes carried out on the results obtained in the literature review and in the application of a survey, evidenced in the work of Soares and Oliveira (2020a).

Subsequently, the "Identifying the Gamification Elements " step was developed, where the elements of gamification that could be used to minimize or treat each SPI problem found in the previous step were identified and correlated (Soares and Oliveira, 2020b).

Thus, the identification of the elements made it possible to carry out the “Elaborating Dynamics of Use of the Gamification Elements” step, where targeted solutions for the use of the elements to address the problems were developed.

With the completion of the previous step, there was a need to perform the “Performing Peer Review” step, in which there was a more careful analysis and review by an expert on the strategies developed and the use of the predefined gamified elements.

The future steps of this research involve the definition of a detailed dynamic that addresses how the practical application of gamified elements should occur in relation to the SPI problems. From this definition, there will be the application of the dynamics developed in a real scenario (organizational context), by means of case study, in order to collect and analyze data in relation to performance and possible problems that may occur with its application.

3 SPI PROBLEMS

The SPI problems, shown in Table 1, were identified in the work of Soares and Oliveira (2020a), who carried out a survey of the problems from two perspectives: analyzes carried out in the literature and another based on analysis of results obtained with the application of a survey.

In total, twenty problems were identified, eight of which were evidenced with the analysis in the literature and twelve of the survey application. The literature review allowed identifying problems and difficulties existing in the literature that occur during the implementation of SPI. With the application of the survey, it was possible to obtain information on the impact (occurrence) that the problems detected in the review caused, in the perception of the participants, according to their experience in SPI, and also contributed to obtain new existing problems according to reports from the participants.

4 RELATION OF PROBLEMS WITH THE ELEMENTS

It is noteworthy that in (Soares and Oliveira, 2020b) there were activities focused on the elaboration of the mapping of gamification elements, present in the Octalysis Framework of Chou (2016), eligible to meet the SPI problems identified in the literature and in the survey. It is important to emphasize that this framework addresses a broad context of application the gamification concepts, while in the work carried out it was correlated to the problems faced in the SPI initiatives. In addition, forms of treatment (possible solutions) were identified in the literature for such problems and correlated with established gamification elements, in order to support the application of the element in the SPI context.

Table 1: Problems identified in the literature and reported in the survey.

Research Perspective	Problems Identified
Review of the Literature	Organizational culture change
	Lack of Knowledge in Software Engineering
	Lack of understanding of the responsibilities of those involved people
	Lack of support tools
	Lack of / little commitment from senior management
	Little support from employees
	Turnover of staff involved
	Lack of / little qualified human resources
Survey	Focus on certification instead of focusing on improvement
	Lack of government incentive
	Reduction in consulting hours as a way to reduce costs
	Lack of knowledge of the importance of qualiy standards by the market
	Lack of / little projects to validate an improvement program
	Bureaucracy in improvement programs
	Continuity of team engagement in the defined process
	Lack of / little knowledge of the quality standards by employees
	Different interpretations in relation to the quality standards
	Lack of consistent project portfolio planning
	Lack of consistent planning by the organization's senior management
	Lack of flexibility of quality standards

Table 2 shows the mapping performed, where for each problem one or more elements to be used were identified.

It is also important to mention that the mapping carried out sought justifications in the literature, in order to verify whether the solutions proposed in the literature addressed in a gamified way or raised arguments that resembled some game element prescribed in the Octalysis Framework. Thus, the mapping of the gamification element to the SPI problem was based on two perspectives: i) justification of solutions based on the Octalysis Framework and in ii) justifications for solutions evidenced in literature.

The results obtained with the correlation between element and problem made it possible to describe strategies of solutions directed to the problems, which will be described in the following section.

Table 2: Mapping problems to gamification elements.

SPI Problems	Gamifcation Elements
Organizational culture change	- Narrative - Free Lunch - Rockstar effect - Building from scratch - On-boarding / Step-by-Step Tutorials - Appointment Dynamics - Brilliant Choice
Lack of Knowledge in Software Engineering	- Progress Bars - On-boarding / Step-by-Step Tutorials - Brilliant Choice
Lack of understanding of the responsibilities of those involved people	- Narrative - On-boarding / Step-by-Step Tutorials - Brilliant Choi
Lack of support tools	- Building from scratch - On-boarding / Step-by-Step Tutorials - Brilliant Choice
Lack of / little commitment from senior management	- Narrative - On-boarding / Step-by-Step Tutorials
Little support from employees	- Narrative - Free Lunch - Badges / Achievements - Mentoring
Turnover of staff involved	- Free Lunch - Rockstar effect - On-boarding / Step-by-Step Tutorials - List of Rewards / Lottery
Lack of / little qualified human resources	- Progress Bars - On-boarding / Step-by-Step Tutorials
	- Brilliant Choice
Focus on certification instead of focusing on improvement	- Narrative - Building from scratch
Lack of government incentive	- Elitism
Reduction in consulting hours as a way to reduce costs	- Narrative
Lack of knowledge of the importance of qualiy standards by the market	- Elitism
Lack of / little projects to validate an improvement program	- On-boarding / Step-by-Step Tutorials
Bureaucracy in improvement programs	- Narrative - Building from scratch - On-boarding / Step-by-Step Tutorials - Mystery Boxes / Random Rewards
Continuity of team engagement in the defined process	- On-boarding / Step-by-Step Tutorials - Appointment Dynamics
Lack of / little knowledge of the quality standards by employees	- Narrative - On-boarding / Step-by-Step Tutorials - Brilliant Choice
Different interpretations in relation to the quality standards	- Narrative - On-boarding / Step-by-Step Tutorials
Lack of consistent project portfolio planning	- On-boarding / Step-by-Step Tutorials
Lack of consistent planning by the organization's senior management	- Building from scratch - On-boarding / Step-by-Step Tutorials
Lack of flexibility of quality standards	- Narrative

5 PROPOSAL FOR THE USE OF GAMIFICATION ELEMENTS TO SOLVE SPI PROBLEMS

In order to guarantee the proposed use of this work, this section discusses the strategies for applying the gamification elements. These strategies should be seen as possible solutions to be used by organizations to assist them when they encounter situations, in which SPI problems occur.

The occurrence of these problems in organizations is due to the lack of an effective strategy to successfully implement the quality standards and models. Thus, it is important to highlight that the software process improvement

initiatives cause changes to be effectively established in the development process; therefore, the implantation rarely occurs spontaneously (Niazi, 2009).

Therefore, it is important to maintain the engagement and motivation of those involved people. For Vianna et al. (2013) the level of engagement of the individual in the scenario is influenced by the degree of dedication of the individual to the designated tasks. This dedication, in turn, can be achieved with the proposed solutions with the elements of gamification as it is applied to stimulate the individual's behavior.

It should also be noted that the gamified elements were related to the problems that occur in SPI implementations, with the development of strategies directed to use in the organization, in order to minimize the occurrence of these problems. Therefore, these strategies were not developed to be applied to a specific improvement model ou standard, and it is not possible in the proposal to consider a process area or an activity directed to the application, since the purpose of the application is precisely to be applicable to any model or standard, favoring a substantive dynamic for organizations.

In view of the above, the following subsection will describe how the elements of gamification should be applied.

5.1 Narrative

The application of this element should involve explaining the purpose of implementing the improvement process, including the needs, reasons and expected results. As well as, to present to collaborators the dynamic way that the process must be applied, involving all activities and approaches to the execution of tasks and communication.

It is also important to involve the employee in a playful context, with different profile assignments than those they exercise in the initiatives, such as the name of heroes, characters from films or cartoons, but with the evidence of their due responsibilities, according to the scenario used by the organization.

5.2 Building from Scratch

The application of this element requires the involvement of employees in a more active way, in the structuring of the process in the organization, since they must contribute with suggestions and opinions in relation to what will be developed to provide a collaborative environment of creation and participation in the improvement process.

5.3 On-boarding / Step-by-Step Tutorials

The application takes place in the assignments, guidelines and information provided to those involved people, by a person whose competence is to be an expert in the area of SPI and / or to be an expert in the area of Gamification, in order to answer questions and promote knowledge, commitment and support the actions and strategies created to achieve a better performance in its activities.

5.4 Progress Bars

This element must be applied when creating a Track of actions for the learning of those involved people, and from this must be given to those involved people a way of visualizing their progress according to the fulfillment of the actions established for their training.

5.5 Free Lunch

The application of this element must occur with the provision of rewards to employees related to the delivery of demands that are their responsibility in the SPI journey.

5.6 Rockstar Effect

This element is applied with the creation of a context of recognition of the work performed to the employee from the perspective of the team itself (internal perspective), based on the dynamics of delivering something symbolic of recognition to highlight the importance of the employee in the improvement initiative.

5.7 Brilliant Choice

This element is applied when it is possible for employees to request faster and more targeted guidance from another employee when they experience difficulties in carrying out their activities / demands, since if they were to resort to training cases, it would be more time consuming and costly.

5.8 Elitism

It should be applied to promote strategies, internally and externally, of the benefits of adopting an improvement program in the organization, clarifying to those involved people the importance of

contributing and participating in this implementation, which provides the feeling of pride in acting in the context of SPI and also from an external perspective, the disclosure of benefits can lead to a competitive advantage in the market by the organization.

5.9 Badges / Achievements

The application of this element is conditioned to the application of a strategy similar to that promoted with the loyalty card, where each completed action must have a series of rewards / awards to employees who effectively fulfill the deliveries necessary for the success of the improvement program.

This strategy should also be similar to a scoring system, where the more the person completes his demands, the more points he accumulates to have his rewards / prizes.

5.10 List of Rewards / Lottery

It is applied with the availability of rewards delivered to those involved when they complete their demands, using a digital roulette wheel, where the reward is linked to luck, a factor that is impossible to control. So the employee spins the roulette wheel with the possible rewards and waits to find out what reward he got.

5.11 Mystery Boxes / Random Rewards

The use of this element must be provided to the employee when he manages to maintain an excellent performance in the deliveries established in relation to his demands, the permanence in this state must guarantee a bonus. This bonus is a secret reward and without a predetermined time.

5.12 Appointment Dynamics

The use of this element occurs when employees are established to use a tool, for example, Trello, Taskboard, Habitica, Slack, among others, to help them to remember in a recurring way what must be developed of actions to achieve the expected results, as well as monitoring and management of these actions.

6 EVALUATIVE DISCUSSION

In the solutions proposed with the gamification elements, a more careful analysis took place by an expert in the area of software engineering, in the strategies developed and the use of the predefined gamified elements to the SPI problems. This analysis took place with the peer review technique.

Peer review can be implemented with a simple review, where only one person reviews the work product, provided that: the reviewer is not the author of the document itself, who has knowledge of the document to review its content, and that objective criteria be used for the review (SOFTEX, 2016).

It is emphasized that the definitions of the strategies were constantly reviewed and evaluated by an expert with the objective of achieving / guaranteeing the expected purpose of applying the element in the context of gamification. For Deterding and Dixon (2016), gamification means using elements of game design in other contexts not related to games in order to engage people to achieve a goal. In this study, the application context is the SPI initiatives.

Thus, the expert's considerations were based on the Octalysis Framework, which has its structure organized in eight Core Drivers and their corresponding correlated game elements. Core Drivers represent basic and fundamental factors in games that provide the motivation to perform a variety of activities and discussions. In addition, depending on the game strategy and scenario used, there are the elements or techniques to engage the participants, which in this case are the game elements, which are factors capable of boosting the participant differently, where some strategies stimulate the from inspiration and empowerment and others from obsession and manipulation (Chou, 2016).

In Core Drive 1 (Epic Meaning & Calling), the use of the elements Narrative, Free lunch, Elitism, substantiates what was expected by this drive, as it makes the involved person believes that he is participating or contributing with something bigger, that is, of great relevance, which generates to the involved feelings of recognition, of being a fundamental person to execute the necessary actions.

In Core Drive 2 (Development & Accomplishment) the use of the elements Rockstar effect, Progress bars, Badges / achievements, confirms the development of internal motivation in those involved people in relation to progressions, in the development of skills, in the achievement of mastery and, eventually, in overcoming challenges, with the representation of points, badges and leaderboards, and thus guaranteeing what is expected in this core drive.

From the Core Drive 4 (Ownership & Possession), only the Building from scratch was used, this was justified by providing those involved people with the motivation to own something and, consequently, contribute to improvements, because when the person feels ownership over something, they wants to improve what you have.

In Core Drive 5 (Social Influence & Relatedness), application of the On-boarding / step-by-step tutorials element supports what was expected by this core drive, as it involves activities inspired by what other people think, do or say. In other words, it incorporates all the social elements that motivate people, which include guidelines, social acceptance, social feedback and companionship.

As for Core Drive 6 (Scarcity & Impatience), the Appointment dynamics element was used, which confirms what is expected by this core drive, as it is a form of impulse that motivates to want, and directs the search for results, in contexts that have great difficulties.

From the last Core Drive 7 (Unpredictability & Curiosity) the elements used were: Brilliant choice, List of rewards / lottery and Mystery boxes / Random Rewards. These elements guarantee what is expected by this drive, as it is the drive of constant involvement, because when something does not fit into its regular pattern recognition cycles, its brain kicks in and pays attention to the unexpected. Therefore, it is also the main force behind our affection for experiences that are uncertain and involve chance.

It should also be noted that only the Drivers and elements that were used in the strategies developed in the context of SPI were justified, in terms of the expected result, in this work.

7 CONCLUSION

For Montoni (2010), the success in implementing Software Process Improvement depends fundamentally on strategies and approaches adopted to support the execution of such initiatives. Thus, the absence or inadequacy of these approaches is one of the most common reasons for the failure of improvement initiatives.

Although there are studies that address the problems evidenced in the improvement programs, few studies still seek to identify practices in order to mitigate the negative effects of critical factors (Mendes et al., 2007).

In this context, this work aimed to present strategies for using elements of gamification, present in the Octalysis Framework by Chou (2016). These strategies should be seen as possible solutions to be used by organizations to assist them when they encounter situations, in which SPI problems occur.

The use of gamification is justified because it aims to transform activities and make them more attractive and fun by the use of techniques and elements of games, so as to increase people's motivation when performing tasks (Menezes et al., 2016). Thus, it is expected that with the use of the elements of gamification the problems will be treated or minimized in an appropriate, efficient and effective way, where those involved people can obtain a great performance by interacting in a motivated and engaged way in the SPI. According to Muzeka and Marquardt (2017), with gamification the individual has the possibility to get into tasks and solve problems and achieve goals.

In view of the above, it is intended as future work to: a) describe in a structured and playful way, a dynamics of application of the elements of gamification in a context of SPI, with the necessary specifications of procedures and necessary resources, adequate for the treatment of problems or recurring difficulties in implementing improvements, and b) apply the gamified solutions in a real scenario, aiming to collect and analyze data in relation to performance and possible problems that may occur with its application.

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