Application of a Gamified Approach to Learning in the Treatment of Problems in Software Process Improvement: Analysis and Discussion of Results

https://doi.org/10.3991/ijet.v17i11.30671

Elziane Monteiro Soares(✉), Sandro Ronaldo Bezerra Oliveira, Isaac Souza Elgrably, Rodrigo Henrique Barbosa Monteiro
Graduate Program in Computer Science (PPGCC), Federal University of Pará (UFPA), Pará, Brazil
msoares.elziane@gmail.com

Abstract—The specialized literature defines Software Process Improvement (SPI) as the fundamental approach to improving software products in software development organizations. In this context, studies report several problems and difficulties that organizations face during the implementation of improvements. Although there are studies that address the problems highlighted in improvement programs, few studies still seek to identify practices in order to mitigate the negative effects of critical factors. Thus, the objective of this work is to discuss and analyze the results obtained in an Experience Report that consisted of a dynamic application with gamification elements in an SPI context related to learning in the treatment of recurring problems or difficulties in the implementation of improvements. It is noteworthy that the dynamics can be developed in organizations (commercial and academic) regardless of the improvement model or standard desired, since it was elaborated in relation to common problems experienced and identified in the SPI implementations scenario. The analysis of the obtained data was performed using an Evaluation Framework for Gamification in Software Engineering, which provided a standard structure for the design of evaluation studies for gamification cases.

Keywords—software process improvement, gamification, teaching and learning, problems and difficulties

1 Introduction

Organizations (commercial and academic) are showing more and more interest in adopting improvement programs in their software processes in order to produce quality software. This interest is driven by the demand level for the quality of services provided by software companies, linked to market competitiveness, as well as the systemic productivity of the software sector [1], [2].

Studies carried out in the software sector in Brazil point to a growth of 28.7% from 2019 to 2020. The growth of the software sector can be attributed to the way companies

were forced to change their work structure, due to the confinements caused by the pandemic and the increase in the home-office modality that followed. In order to continue to conduct their business, companies bet on introducing new products, increasing IT (Information Technology) security, increasing productivity and reducing costs [3].

For García et al. [4], the software sector will be in constant change, as innovative technologies are continuously developed, new customers and demands arise, and competitors enter to compete for market space. Thus, the authors point out that an important factor for ensuring the survival of software organizations is the ability to implement improvements in their processes to meet the growing needs of software. For Mendes et al. [5], Software Process Improvement (SPI) aims to know, define and / or improve the processes related to software development to make them more effective and efficient.

There are recommendations in the literature of models, standards and norms that are references to guide a software process improvement initiative in an organization. However, regardless of the models to be adopted, an effective management of the changes to be implemented is necessary for a software process improvement to be successful [6].

Studies carried out in the context of software report problems and difficulties that organizations face to implement SPI based on process models and standards. However, the successful implementation of SPI initiatives fundamentally depends on the strategies and approaches adopted to support the execution of such initiatives. Thus, the absence or lack of adequacy of these approaches is one of the most common reasons for the failure of improvement initiatives [1]. In addition, other factors are also identified as causing failures in the conduct of these initiatives, such as social and cultural factors, lack of communication, motivation and support from top management [7].

Although there are studies that address the problems highlighted in improvement programs, few studies still seek to identify practices to mitigate the negative effects of critical factors [8]. Thus, it is important that every SPI initiative considers methods and techniques in the proposed processes to facilitate the implementation and, thus, minimize the negative effects perceived by those involved in the process [9].

In view of the above, it is noticeable the need to use strategies and approaches in conducting software process improvement initiatives to address or minimize the problems or difficulties identified in SPI implementations. Thus, a strategy that can help in this problem is the use of gamification elements, as a technique that uses elements of technology-enhanced learning, since it encompasses the use of mechanisms and game systems for problem solving and for motivation and engagement of a particular audience [10]. The authors in [11], [12] report many companies have used game strategies to motivate and engage the employee, not only in productivity and fun, but also to encourage and teach innovation and development of their tasks.

Gamification also allows the definition of mechanisms that provide people with motivation and learning to increase productivity and performance, foster innovation, collaboration and participation [13], [14], and offer the opportunity for better user involvement, faster feedback on accomplishments, and more visible progress indicators of continuous software process improvement [15].

Thus, the use of gamification elements can contribute to the definition of teaching and learning mechanisms to stimulate people's motivation and commitment to effectively join and participate in SPI initiatives. This is justified by the fact that gamification uses methods derived from games such as those that use highscore lists, continuous and constant feedback, and the use of rewards with the aim of turning supposedly tiring work into an attractive and stimulating activity [16].

Chou [17] points out how the greatest contribution that gamification can offer to society would be the opposition to the traditional Functionality-Focused Design model for Human Aspect-Focused Design. According to his theory, most of the known production systems are oriented to facilitate that tasks are carried out in the shortest possible time. The simple consideration that the people who perform these jobs have feelings, insecurities and opinions about what is expected of them, or about how they should achieve their professional goals, in itself represents a shortcut for their true motivations to be activated.

For Chou [17], the game elements are factors capable of driving the participant's behavior differently, where some strategies stimulate from inspiration and training, and others from obsession and manipulation. The game elements proposed by the author are structured in the Octalysis Gamification Framework organized into eight Core Drivers and their corresponding correlated game elements (see Table 1). Core Drivers represent basic and fundamental factors in games that provide the motivation to perform a variety of activities and discussions.

Table 1. Core Drivers and their corresponding game elements

Core Drive	Elements
Core Drive 1: Epic Meaning & Calling	Narrative; Humanity Hero; Elitism; Beginners Luck; Free lunch.
Core Drive 2: Development & Accomplishment	Progress bars; The Rockstar Effect; Achievement symbols; Status Points; Classification.
Core Drive 3: Empowerment of Creativity & Feedback	Boosters; Milestones unlock; Choice Perception; Meaningful Choices.
Core Drive 4: Ownership & Possession	Build from scratch; Collection sets; Exchangeable Points; Observer Attachment; Alfred effect.
Core Drive 5: Social Influence & Relatedness	Mentorship; Brag Buttons and Trophy Shelves; Group Quests; Social Treasures; Social Prod; Conformity Anchor; Water Coolers.
Core Drive 6: Scarcity & Impatience	Dangling and anchored juxtaposition; Magnetic Caps; Appointments Dynamics; Torture Breaks; Evolved UI.
Core Drive 7: Unpredictability & Curiosity	Glowing choice; Mystery Boxes / Random Rewards; Easter Eggs / Sudden Rewards; List of Rewards / Lottery.
Core Drive 8: Loss & Avoidance	Legitimate inheritance; Evanescence opportunities; Status Quo Sloth; FOMO Punch; Sunk Cost Prison.

In the organizational context (commercial and academic), employee engagement is essential to achieve the expected goal, so with the application of gamification, intrinsic motivation is aimed at team members. It is noteworthy that gamification is not just giving back to the employee, but motivating him to achieve the reward in a gamified

way [18]. For Hamari and Koivisto [19], gamification in a business and academic environment promotes intrinsic changes that provoke the individual to participate in the application of the method. Therefore, above any reward offered in this type of method, gamification seeks to value the personal factor, whether in the relationship with the team, or the appreciation of the individual himself in engaging him to achieve his goals.

In view of the above, this work aims to present the results of the application of a proposal for a solution to SPI problems from the use of gamification elements suitable for the treatment of problems or recurring difficulties in the implementation of improvements, since gamification was identified as a teaching and learning tool that leads to motivation and commitment in several areas [20], [21], including Information Technology and, more specifically, Software Engineering [15]. The results were scaled using the framework for evaluating gamification in Software Engineering by Monteiro et al. [22]. Thus, the research question of this article is: Did the gamified approach help to solve problems or difficulties in the implementation of SPI?

In addition to this introductory section, this article is structured as follows: Section 2 presents the context and issues present in SPI implementations, Section 3 presents the research methodology, detailing its main stages, Section 4 presents related works to the context of this work, Section 5 addresses the gamification evaluation strategy used in the study, Section 6 details the analysis of the results obtained, Section 7 presents discussions regarding the results obtained in the research, Section 8 details the threats to validity that have been identified and, finally, Section 9 presents the conclusions and future work.

2 Software process improvement

According to Moreira [23], several studies carried out in recent years have shown the importance of the systematic and disciplined use of processes for a software company to be successful. This success is related to aspects, such as: increased competitiveness, ability to take greater risks, increased product quality, productivity gains, lower costs and elimination of rework.

The implementation of improvements in software processes is a complex and knowledge-intensive activity [24]. This means that those involved in the initiatives must have knowledge about software engineering and be able to use it to guide the implementation of improvements in the organization's processes, increasing the chances of achieving the expected results [25].

Pressman [26] emphasizes that the lack of adoption of methods, tools and procedures in software development has reached significant numbers of unfinished projects, and completed projects that do not meet customer needs. Other sociocultural issues, such as lack of motivation, are also identified as causing failures in the conduction of improvement initiatives [27].

Mendes et al. [5] report that process improvement deals with issues associated with the analysis, description and improvement of processes related to Information Technology. Several aspects need to be considered in process improvement initiatives, such as: resource allocation, choice of processes to be analyzed and improved, selection of pilot

project(s), choice of models to be used and the approach adopted to proceed the initiative.

Researchers such as Habib et al. [28] state that "any significant software process improvement requires a significant investment, time and money". So that these variables are not wasted, it is necessary to carry out a feasibility study and plan the change and improvement. According to Birk and Pfahl [29], this requirement motivated the emergence of standards and reference models, which are used as a basis for the implementation of improvements in software processes.

2.1 Identification of software process improvement problems

Studies carried out in the context of software process improvement (SPI) report problems and difficulties that organizations face to implement process models and standards, mainly related to the inability to overcome some critical factors [30]. Therefore, to identify and analyze the problems and difficulties experienced in SPI initiatives, the authors [31] present in their work the identification and analysis of problems or difficulties, conducted from two perspectives: analyzes carried out in the literature and another from analysis of results obtained from the application of a survey. According to Niazi et al. [25], the accumulated knowledge about critical success factors from the views, experiences and perceptions of people who work in this scenario can help to define more efficient strategies for implementing SPI.

Thus, the literature review allowed the authors [31] to identify 8 (eight) problems and difficulties in the literature that occur during the implementation of SPI. Table 2 presents the problems, the description and the number of times that a given problem was identified in a total of 54 studies.

Subsequently, there was the identification and analysis of the problems and difficulties obtained from the application of a survey by the authors [31]. In total, 12 (twelve) new recurring problems were identified, from the application of the survey, and 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 MPS, the detailed reports of the participants in relation to the problems detected in the literature, are specified in the work [31]

Table 2. Problems or difficulties identified in the literature

Problem / Difficulty	Description	Citation quantity
1. Culture change in the organization.	It occurs in SPI implementations because there is great resistance on the part of employees in relation to the standardization imposed in the improvement models for the organizational process, since they already adopt their own approach in their routine.	32
2. Lack of knowledge in software engineering	This lack is evidenced in basic procedures necessary in the implementation of the improvement program, where employees are unaware or do not understand technical terms (concepts) or routine activities used in software engineering.	30

3. Lack of understanding of stakeholder responsibilities	Evidenced when roles are not fully established or understood and, in some cases, are vaguely defined, which can make it difficult to understand and progress the process.	17
4. Lack of support tools	Consequence of the lack of standardized tools to support the execution of processes, since without adequate tool support, the development of activities adhering to quality models can be harmed.	15
5. Lack of / little commitment from top management	The non-commitment of top management can affect the progress of the improvement as a whole, since the management is the initial source of investments, resources and decision-making, fundamental to the incentive and support of those involved in the implementation of the improvement.	27
6. Little support from employees	It occurs when employees do not understand the purpose of formalization and discipline in the execution of processes; or in other cases, they even understand, but do not accept, precisely because they do not believe that the improvement will occur with the implementation of SPI. This view contributes to the lack of commitment and motivation to learn about the new practices introduced by the processes.	24
7. Employee turnover	It can negatively affect process improvement activities, as it contributes to the loss of skilled and active individuals in the process, as well as the loss of tacit knowledge. All this can delay and cause a rework in the activities proposed in the application of the model.	8
8. Lack of / little qualified human resources	This problem highlights the difficulties that employees may have during the implementation, due to the unpreparedness to develop the necessary activities, which arise from existing gaps in their qualification.	13

These problems are presented in Table 3, as well as the description and the number of times that a given problem was mentioned by the respondents.

Table 3. Problems or difficulties identified in the survey

Problem / Difficulty	Description	Number of reports
1. Focus on certification instead of focusing on improvement	It occurs in situations where the organization only aims to achieve the final result, directing to a certain certification, without worrying about understanding and dedicating itself to meeting the necessary requirements to reach the pre-established objectives in the SPI.	3
2. Lack of government incentive	The occurrence of this can impact the motivation of those involved in the implementation, since the non-recognition by the government, in the form of financial incentives or not, can negatively influence the work of organizations that seek quality and, consequently, make it difficult to achieve competitive advantages in relation to the market.	3
3. Reduction in consulting hours as a way to reduce costs	It can happen when there is no understanding of the context of application of SPI to those involved, so the lack of understanding will lead them to apply mechanisms to circumvent possible steps and, consequently, reduce costs inappropriately. However, these strategies can negatively impact the results of important steps in the process in question.	1
4. Lack of knowledge of the importance of models by the market	It considers the gaps that exist in understanding in relation to improvement models. Many employees are unaware of the real importance of having a quality seal associated with the organization's image, as they do not understand that the model adds more value to	1

	the context of the organization's performance in relation to the market. A quality seal is very important, as it conveys the message that an organization develops more qualified services, adequate to structural, technical and human resources terms.	
5. Lack of / few projects to validate an improvement program	It is evident when the organization does not direct the projects developed to a more careful supervision, which considers the objectives set by the company and at the same time adheres to the requirements intended in the improvement programs.	1
6. Bureaucracy in improvement programs	It arises from the perspective that these programs bring, in their implementation, many procedures that must be fulfilled to achieve the expected results, which is often seen by employees as something time-consuming to be applied on a daily basis.	1
7. Continuity of team engagement in the defined process	In relation to the "Continued engagement of the team in the defined process", it is recurrent because the organization does not propose strategies to encourage employees in the continuation of the procedures that were pre-established.	1
8. Lack of / little knowledge of models by employees	It occurs when employees do not understand all the procedures described in certain models and cannot perceive the benefits they can provide. This fact causes the lack of interest of such individuals in not using the intended improvement model, which, consequently, causes the lack of knowledge of all the guidelines to be followed, directly harming the implementation of the SPI.	1
9. Different interpretations in relation to the models	Those involved may have different perceptions about the models, as a result of the reality and experience lived by these employees in each organization, as well as when the responsibilities and procedures to be carried out in the SPI are not clearly established.	1
10. Lack of consistent project portfolio planning	The neglect of this can directly affect the organization's results, since its correct application is seen as an effective tool in the analysis and quantification of the value of each project. Such benefits make it possible to prioritize projects that are more aligned with the company's objectives.	1
11. Lack of consistent planning by the top management of the organization	It happens when the organization does not establish a structured way to meet its future demands and needs in relation to impacts, intelligent and timely decision making.	1
12. Lack of model flexibility	It refers to the application context that is seen by those involved as something very rigid and complex, full of divisions, rules and procedures that they consider to be redundant and unnecessary for operation.	1

Based on the problems listed, in [31], it was possible to carry out a study more focused on understanding each problem. This understanding contributed to the mapping of gamification strategies to address or minimize the impacts that these problems cause during the implementation of SPI, from the point of view of teaching and learning.

3 Research methodology

In order to achieve the objectives of this research, a sequence of steps was established and followed. Thus, the methodology carried out in this work comprised the steps shown in Figure 1, described in the following sections: 1) Identify the SPI problems, 2) Identify the gamification elements, 3) Develop dynamics for the use of gamification

elements, 4) Define dynamics that integrate all the gamified elements in relation to the problems, 5) Application of gamification for problem solving and 6) Analysis the studies data.

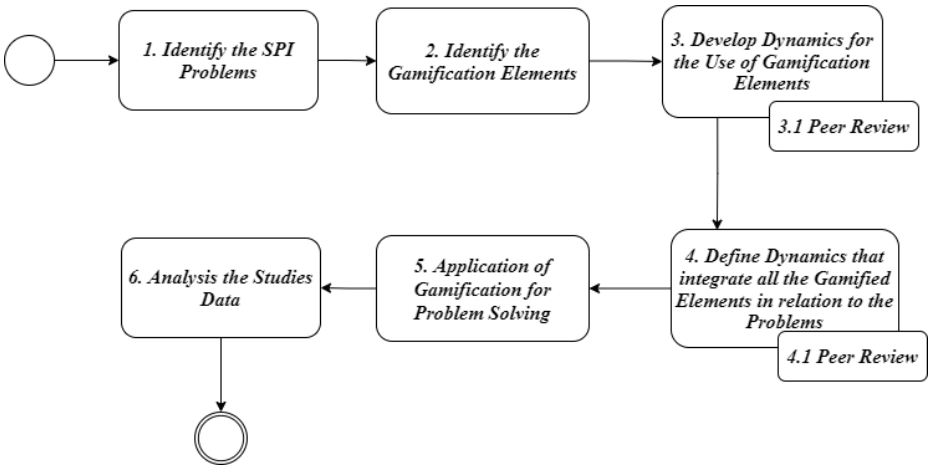

Fig. 1. Work execution steps

3.1 Step 1: Identify the SPI problems

As mentioned earlier, at this step, problems and difficulties were identified based on analyzes carried out on the results obtained in the literature review and in the application of a survey. In the review carried out, 54 studies were selected and included for analysis. As for the survey applied, an electronic form was made available to the research participants for a period of one month, in which 32 responses were obtained from the participants. The details of the problems or difficulties identification described in this step can be consulted in [31].

3.2 Step 2: Identify the gamification elements

In this step, the gamification elements used to minimize or treat the twenty SPI problems found in the previous step were identified and correlated. Thus, for its realization, it was necessary to study gamification concepts and elements that are addressed in the Octalysis Framework [17], and for each problem one or more elements were identified, the Core drive to which each element belongs, as well as the justifications for each problem. application of the elements, potentially capable of minimizing or solving the problems in question. The details of this step can be found in [32].

The Octalysis Framework is divided into eight Core Drivers, which represent basic and fundamental factors in games that provide the motivation to perform a variety of activities and discussions. Linked to the Core Drivers, there are elements or techniques to engage the participants, in this case are the game elements, which are factors capable

of driving the participant differently, where some strategies stimulate from inspiration and training and others from the obsession and manipulation [17].

Table 4 presents the description of the elements that were mapped only for the problem "Culture change in the organization". However, in [32] contains the mapping carried out to the other problems, as well as the application justifications and the description of this information for all the elements used that make up the framework.

Table 4. Gamification elements mapped to the problem "Culture change in the organization"

Problem / Difficulty	Core Drive	Elements
Culture change in the organization.	1 - Epic Meaning & Calling	Narrative
	1 - Epic Meaning & Calling	Free lunch
	2 - Development & Accomplishment	Rockstar effect
	4 - Ownership & Possession	Build from scratch
	5 - Social Influence & Relatedness	Tutoria
	6 - Scarcity & Impatience	Appointments dynamics
	7 - Unpredictability & Curiosity	Glowing choice

3.3 Step 3: Develop dynamics for the use of gamification elements

In this step, isolated solutions were developed using the elements to deal with each specific problem. This step was developed according to the reasoning presented in the Octalysis Framework for the element mapped in the previous step, in which there was an in-depth study of the element that made it possible to structure strategies for the application of the element in the context of SPI, which must be used by organizations when these encounter situations in which problems occur. The isolated solutions were reviewed and evaluated by an expert in order to ensure the expected purpose of the application of the element in the context of gamification [33].

Table 5 summarizes how the selected gamification elements should be applied to problems, considering isolated solutions using the elements.

Table 5. Description of the strategy to be used according to elements

Elements	Description of application strategy
Narrative	It involves explaining the purpose of implementing the improvement process, dynamically to employees, including needs, reasons and expected results.
Build from scratch	It 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.
Tutoria	It occurs in the attributions, guidelines and information provided to those involved, by a person who has the competence to be an expert in SPI and / or to be an expert in Gamification.
Progress bars	It requires the creation of a Track of actions for the learning of those involved, and from this, those involved must be given a way to visualize their progress according to the fulfillment of the actions established for their training.
Free lunch	It occurs with the provision of rewards to employees related to the delivery of the demands that are under their responsibility in the SPI journey.

Rockstar effect	It creates a context of recognition of the work performed by the employee from the perspective of the team itself (internal perspective).
Glowing choice	It provide faster and more targeted guidance from another employee when they experience difficulties in performing their activities / demands.
Elitism	It promotes strategies to disseminate the benefits of adopting an improvement program in the organization, externally, in order to obtain a competitive advantage in the market for the organization.
Achievement Symbols	It applies of a strategy similar to that promoted with the loyalty card, where for each completed action there must be a series of rewards / awards to employees who effectively fulfill the deliveries necessary for the success of the improvement program.
List of Rewards / Lottery	Rewards must be made available to those involved when they complete their demands, using a digital roulette wheel, where the reward is linked to the luck of the employee.
Mystery Boxes / Random Rewards	It provides the employee with a bonus, when he manages to maintain an excellent performance in the deliveries established in relation to his demands. This bonus is a secret reward and without a predetermined time.
Appointments dynamics	It occurs with the disclosure to the hero of the performance of his actions, which favors a follow-up, in relation to the result that was obtained and expected, this strategy allows the hero to modify his positioning and seek better results.

In the solutions proposed with the gamification elements, a more careful analysis was carried out, by an expert in software engineering, of the strategies developed and the use of predefined gamified elements for SPI problems. This analysis took place with the completion of the peer review. Thus, the expert's considerations were based on the Octalysis Framework. The details of the isolated solutions for the use of elements to deal with each specific problem, as well as their review process by an expert at this stage, can be consulted in [33].

3.4 Step 4: Define dynamics that integrate all the gamified elements in relation to the problems

At this step, a dynamic was developed for those involved in the improvement initiatives, with the interrelated use of the gamification elements to the SPI problems listed. The dynamic includes the procedures, methods and materials necessary for full use in improvement initiatives [34].

The dynamics elaborated explores a context of heroes with an analogy to the Avengers movie, since the work carried out in organizations (commercial and academic), as well as in the context of the movie, depends on the performance and effort of the entire team to achieve the expected results. The heroes' journey is composed of a group of missions, arranged on the map of secret processes in Figure 2, and each mission contains tasks to be performed, specific materials to be used, as well as evaluative actions that must be carried out by the heroes to who can get points in each mission.

Fig. 2. Secret process map

There are three profiles involved in gamification dynamics: a) Operations Instructor (OI), whose competence is to be an expert in SPI and / or to be an expert in Gamification, b) Avengers (VG), which is the Organization's team of employees (commercial or academic), who act directly in the actions necessary to improve the desired process, c) Government Representatives (GR), who are representatives who work in the Organization's Senior Management who have a holistic view of the organization's needs and processes. Each mission has participants who act in its execution, according to the profiles previously exposed. Table 6 presents a summary of mission information.

Table 6. Brief description of the missions that make up the dynamics

Mission	Elements used	Evaluative actions
Mission 1 - Develop Strategies	i) Rockstar effect ii) Elitism iii) Narrative iv) Build from scratch	1. Fill in the Personalization Card 2. Complete the Experience Form 3. Suggestion (Contribution Card) 4. Presence
Mission 2 - Authorize Strategies	i) Build from scratch ii) Tutoria iii) Narrative	1. Analyze and Define Strategy 2. Define Complexity of Activities 3. Suggestion 4. Presence
Mission 3 – Train Hero	i) Tutoria ii) Progress bars	1. Participate in Training 2. Signal Training Satisfaction 3. Suggestion 4. Presence

Mission 4 – Develop Operations	i) Free lunch ii) Rockstar effect iii) Glowing choice iv) Achievement symbols v) List of rewards / Lottery vi) Mystery boxes	1. Develop Low Complexity Activity 2. Develop Medium Complexity Activity 3. Develop High Complexity Activity 4. Suggestion 5. Presence
Mission 5 - Evaluate Mission	i) Appointments dynamics ii) Progress bars	It does not apply, as it is a mission that provides an evaluation in relation to the performance obtained by the heroes with the "Evaluative Actions" present in missions 1, 2, 3, 4. (Quantitative Analysis) It also seeks to obtain feedback from those involved in relation to the motivational factor considering the ARCS Model [35]. (Qualitative Analysis)
Mission 6 – Evaluate Journey	No gamification elements were applied.	It does not apply, as it is a mission that seeks to obtain feedback from those involved in relation to the applied dynamics. (Qualitative Analysis)

The detailing and review process carried out in the dynamics by an expert in which an ID was assigned to each change request, a category to which the request belonged, the item to be adjusted, the comment that justified the reason for the adjustment and suggestion proposal, can be consulted in [34]. It is noteworthy that all the adjustments requested by the expert were implemented, which made it possible to complete the structuring of the dynamics.

3.5 Step 5: Application of gamification for problem solving

To evaluate the application of the proposed gamification dynamics, an Experience Report was carried out in the context of SPI, where we sought to evaluate the applicability of the dynamics as well as the effects of its use. Thus, to carry out the SPI dynamics, the Laboratory institutionalized since 2009 at a Federal University in Brazil, was selected.

Subsequently, the points of improvement that the laboratory needed were verified, so that the improvement model could be defined that would be adopted to meet the needs for improvement in the context of the research laboratory. Therefore, it was verified that the needs were supported from the implementation of the Customer and Market dimension belonging to the MOSE® Competence (Model Guiding for Business Success). The justifications and objectives for choosing the model are present in section 5 of this article.

As for the period of application of the dynamics, this occurred in the interval between 06/24/2021 to 07/29/2021, on Thursdays, from 3:00 pm to 6:00 pm. The meetings took place remotely through the Google Meet tool and with the necessary adaptations to the remote context, due to the restrictions imposed by the COVID-19 pandemic, with the application of social isolation measures. Table 7 presents the schedule followed with dates and definition of the missions that took place.

Table 7. Schedule used in the application of dynamics

Execution	Date	Description (Mission and Time)
E.1	06.24.2021	Mission 1 (3 hours)
E.2	07.01.2021	Mission 5 (30 minutes) and Mission 2 (2 and a half hours)
E.3	07.08.2021	Mission 5 (30 minutes) and Mission 3 (2 and a half hours)
E.4	07.15.2021	Mission 4 (3 hours)
E.5	07.22.2021	Mission 4 (3 hours)
E.6	07.29.2021	Mission 5 (1 hour) and Mission 6 (2 hours)

The dynamics was conducted with the voluntary participation of students / re-searchers who work in the Laboratory, considered as a small business unit. Table 8 contains descriptions of the participants' profile, as well as the code that will be used to designate each one of them during the presentation of the results. There was also one participant, in addition to the seven who accepted to participate, with the attribution of a Judge, who observed the dynamics, checking if the others involved were carrying out the activities. The Judge also filled in the score table according to the evaluative items of the missions. A detailed description of this step will be presented in Section 5 of this study.

Table 8. Description of the participants' profile

Participant code	Training	Research line	Professional activity	Time of experience in Software Engineering
H1	Master (attending)	Software Engineering	Technician	2 years
H2	PhD (attending)	Software Engineering	Technician	4 years
H3	Master (attending)	Software Engineering	Researcher	1 and a half year
H4	PhD (attending)	Software Quality	Professor	10 years
H5	PhD (attending)	Software Engineering	Researcher	4 years
H6	PhD (attending)	Software Engineering	Systems Analyst	4 years
H7	Master (attending)	Software Engineering	Researcher	5 years

3.6 Step 6: Analysis the studies data

The analysis of the data obtained in the Experience Report was carried out using the Evaluation Framework for Gamification in Software Engineering. The purpose of this framework is to provide a standard framework for the design of evaluation studies for gamification cases. The framework considers planning, execution, analysis and reporting of results. The framework used supports the production of empirical data that can be more easily compared [22].

The framework structure is based on the GQIM (Goal-Question-Indicator-Metric) model, which guides the design of evaluation metrics based on a top-down analysis of organizational objectives [36].

According to Monteiro et al. [22], the Framework is organized into evaluation phases and evaluation entities. The evaluation phases describe a sequence of decisions that guide the gamification design review and lead its designer to reflect on the evaluation goals, criteria, questions, required data and data analysis procedures. The evaluation

entities are a set of these data, and their relationship, that need to be documented for the evaluation. The detailed description of the data summarization is addressed in Section 6 of this study.

4 Related works

Herranz et al. [37] present an approach to managing change 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 the improvement of the software process and their commitments 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, such as the issue of teaching and learning.

In Herranz et al. [38] a gamification structure was defined oriented to the needs of the organization and the groups of software professionals involved in a SPI initiative. To establish an adequate gamification framework, the authors emphasized the need to adapt the motivational factors of each of the software professional groups. Although the authors build a gamified structure to help 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 in the improvement initiative.

To validate the gamification framework presented earlier, Herranz et al. [39] used a structure adapted to the particularities of an organization and software professionals to encourage motivation. In this validation, 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 presented framework, its relevance in SPI and its alignment with the standard practices of gamification implementation in organizations. The results obtained in the study were relevant to support the use of the gamification approach in SPI, however the structure was adapted to the particularities of an organization and specific professionals, so it cannot be generalized to other organizations, since the authors are unaware of their needs. This perception is in opposition to what was exposed in the work previously, of creating a structure adapted according to the organization's scenario.

The study by Herranz et al. [40] aimed to bridge the gap between gamification in SPI and empirical evidence by presenting the implementation of the SPI gamification framework in a real environment. The framework validated in the authors' previous work was adjusted and implemented in a small Spanish software development organization, in a controlled experiment, focusing on a team competition (experimental group) to validate its effectiveness. The implementation results show that the application of the structure does not increase staff motivation in SPI tasks, although it contributes to improving their performance. Therefore, the authors point out that the results obtained are a consequence of the use of competitive game mechanics, which may have caused tension between the participants, and this fact can reduce motivation and fun.

As can be seen, none of the studies presented addresses a strategy with gamification elements aimed at each SPI problem, as they approach the problem with the gamification mechanism in a more generalized way to involve participants. Another point noticed in the studies is the absence of a more in-depth description regarding 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 article is distinguished by presenting a strategy of using gamified elements, present in the Octalysis Framework, in relation to specific SPI problems, interrelating the use of each element to the context of the problem to favor teaching and learning of its treatment. It is noteworthy that the mapping did not seek to adapt to a specific size of organization, since the problems dealt with can occur in any organizational environment. Thus, to ensure the generalization and replication of the proposal, this study describes the elements that can be used when the organization is faced with such problems.

5 Gamification application strategy

This section presents the application report of gamification dynamics.

5.1 Planning

As mentioned in Section 3.5, the SPI dynamics was performed at the Laboratory belonging to a Federal University in Brazil. The group is formed by Brazilian professors / researchers, master's and doctoral students / researchers from the Graduate Program in Computer Science and graduation from the Faculty of Computing, which work in the research line of Software Engineering (SE) and Education. From this group, 7 employees in graduate training participated in the dynamic. This number of employees underpins the group as a small profile, which, according to Rouiller [41] is commonly represented when it has 2 to 25 employees and represents enterprises (commercial and academic) that normally, but not restricted, are in early stages of business and learning, demanding urgency for their own survival.

Although the group has existed for more than 10 years, it is possible to identify several problems that occur on a daily basis, among them we can highlight the following: a) Wear with customers due to the absence of clear agreements in relation to the goods and services that are provided, b) Loss of customers, c) Difficulties in understanding the market (or segment) in which it operates, d) Lack of clarity regarding the goods and services that are provided by the business unit (both internally and in relation to the market and/or demander), e) Customers dissatisfied due to lack of compliance (or lack of clarity) of agreements, f) Lack of awareness of which goods and / or products should no longer be in the business unit's portfolio, g) Lack of communication with the target audience, h) Inefficient marketing, i) Lack of knowledge of the availability of service at the business unit, j) Lack of preparedness to handle incidents that occur, including

failure to handle recurring incidents. As explained in Section 3.5, the resolution of problems experienced in the laboratory is supported by the implementation of the Customer and Market dimension belonging to MOSE Competence.

The MOSE is composed of five competence dimensions: Society and Sustainability, Human Talent, Quality, Customer and Market and Innovation, however the problems experienced in the laboratory have support for resolution in the Customer and Market (CM) competence dimension, since that the dimension addresses issues related to the structuring of the enterprise to be able to satisfactorily serve its internal or external customers, the constant analysis of the market (and / or environment) and the impact of the goods and services generated in it. It also emphasizes that an enterprise must focus on generating value for itself and its customers [41].

In this context, the initial need to deal with the problems described above was highlighted, since they are recurrent in the routine of the team in the Laboratory, and the treatment of these problems is something that MOSE itself points out as substantial for an organization that is starting or already has some years of experience in the market, as it helps to remain competitive and innovative, in its offered services and/or produced goods.

In view of the above, the Experience Report carried out the implementation of the CM competence dimension, in the context of the Laboratory, considering the expected results in the Competence objectives of a small business unit.

The implementation of the CM dimension aimed to provide the Laboratory with the scope of improvements in its process, in relation to the quality of the goods and / or services provided, with the treatment or reduction of the problems that occur, since the main focus of this dimension it is the relationship between the business unit and its customers (internal or external to the enterprise) and with the market in which it operates (whether public or private), important factors for organizations that aim to be competitive and help to survive market instability.

It is noteworthy that the strategies structured in the dynamics, in Section 3.4, were not developed to be applied to a specific improvement model, since the objective of the gamification dynamics is precisely to be applicable to any model, favoring a substantive dynamic to organizations. Thus, in the Experience Report, MOSE was implemented in the context of the Laboratory.

To evaluate the results of gamification dynamics in the treatment of SPI problems, as mentioned in Section 3.6, the Framework for gamification evaluation by Monteiro et al. [22] was used. In this step, it was necessary to map information that is important for the evaluation Framework, such as: a) Contextualization of gamification, which is the definition of the gamified approach (with its dynamics, game elements, rules and emotions) of the context in which the approach is applied, b) Contextualization of the Evaluation, which is the definition of the actors of the gamified approach (participants) and the context in which the evaluation is carried out (scientific investigation method, duration, criteria and evaluation questions), c) Definition of Methods, which is the definition of data collection methods (Metrics, Indicators and instruments for data collection and analysis), d) Summarization of results, which is the collection of data and extraction of information to be analyzed (description and duration, samples - demography

and size), e) Outcome Analysis, which is the analysis of data (results for evaluation questions and findings).

5.2 Execution

Firstly, there was an analysis in the context of the Laboratory in order to verify and delimit the scope and the problems experienced in the environment. In this, problems were observed that are dealt with in the Customer and Market dimension of the MOSE improvement model for small organizations, as explained in Section 5.1, for the application of the SPI dynamics.

Subsequently, the invitation was sent to the participants, containing the information and the purpose of the work. Upon acceptance, there was an initial collection of the participant's profile, with information on training, research line, current professional activity and time of experience in software engineering, presented in Section 3.5.

Therefore, meetings were scheduled with the group, using Google Calendar (a tool used to manage the dates and times of the meetings necessary to carry out the missions during the Gamification journey), every Thursday, at 3 pm to 6 pm, from 06.24.2021 to 07.29.2021, totaling six meetings, which were held via Google Meet (tool selected to carry out the necessary meetings to carry out the proposed missions in the gamification scenario). It is important to point out that the number of meetings was directed towards the implementation of a MOSE competence dimension, related to Customer and Market.

As for the materials needed to perform the procedures of each mission, they were made available as materials or as activities to participants in Google Classroom (a tool used to centralize and manage materials, deliverable during the dynamics). It is noteworthy that the dynamics were initially built for the context of face-to-face application, so they needed to be adapted for remote use with the use of tools that met the new reality for this first application, due to the restrictions imposed on organizations in the face of the COVID-19 pandemic.

Then, on 06.24.2021, the execution of the dynamic took place, in which the procedures belonging to Mission 1, covered in Section 3.4, were applied. In it, the procedures regarding internal exposure were adapted for synchronous presentations on Google Meet, and in materials available on Google Classroom regarding: the benefits and advantages of having an SPI model adopted in the organization, information related to institutional knowledge, the organization's strategic objectives in relation to the improvement model and about the rules and guidelines of the game to those involved.

The information exposed to those involved was intended to raise awareness of the importance of adopting the model, generate commitment to the procedures necessary to achieve the expected results for the improvement, as well as obtain suggestions for digital marketing strategies to reach the external public, as well as opinions in relation to what will be developed. These suggestions were collected as an activity in Google Classroom, using the Contribution Card.

In the execution of Mission 1, the participants had to develop the activities created in Google Classroom to assign a hero profile to another employee (Personalization

Card) and provide information regarding their degree of previous experience (Hero Experience Web Form). All these activities were assigned a score and a stipulated time for delivery before the execution of the next mission.

At the end, the room created to manage the SPI dynamics (Google Classroom) was consulted to verify the deliveries made in Mission 1 by the participants. There was also the collection of information related to the presence and suggestion noted by the Judge, which contributed to the completion of the scores in the performance worksheet (Google Worksheet, a tool used to make available to those involved the scores obtained in the actions carried out in the missions). The results obtained in Mission 1 were presented to those involved in Mission 5.

According to the map of secret processes, at the end of each mission it is necessary to carry out Mission 5 (see Section 3.4), so on 07.01.2021 Mission 5 initially took place with the presentation of information on the performance obtained by the heroes in Mission 1 , collected in the Performance Worksheet, and later feedback was obtained from those involved regarding the dynamics of actions established in Mission 1, considering ARCS Model (Attention, Relevance, Confidence, Satisfaction) from Keller [35], since the four categories present in the model represent the necessary conditions for a person to be motivated, that is, each one represents an aspect of motivation.

Subsequently, the execution of Mission 2 took place, initially passing on the instructions of the procedures that would occur in this mission, and later they were presented synchronously in Google Meet, and in materials available in Google Classroom: the summarized experience data of those involved obtained in the Web Form, the Track of learning they will follow on the training mission, the Hero Profile of each participant resulting from the Personalization Card. Still in this first moment, the suggestions proposed by those involved in the Contribution Card were read, and these suggestions were analyzed and selected together with those involved in a brainstorm.

Later, still in Mission 2, the presentation of the expected results of the implementation of the MOSE improvement model took place and there was also a time dedicated to providing guidance to remove doubts. After the presentation of the MOSE, those involved were asked to previously define activities in the Trello tool, through a ticket, of possible activities that, according to the knowledge obtained from the presentation, would make it possible to achieve the objectives expected by the model for the Customer and Market dimension, as well as pointing out a possible priority to the ticket (High, Medium or Low). It is noteworthy that this mission was not fully developed on this second day of execution, as the full definition of activities took place only with the completion of the training provided to those involved in Mission 3.

On the third day of execution (07.08.2021) Mission 3 began, initially passing on the instructions for the procedures that would occur in this mission. Then there was the presentation of the Track of Learning with the guidelines of the context that would be dealt with in the training. The training was then conducted by the Project Coordinator, who has extensive experience in the topics covered in the training related to the practices of the CM dimension, about Processes and Tools.

The laboratory employees who participated in the training were assigned a score on the Performance Worksheet. Another way established for those involved to score in this mission was the feedback at the end of the training actions in the Flag. It is important

to mention that the flag was adapted in the remote structure to be performed in the Padlet tool (a tool used to obtain feedback from those involved from actions developed in the SPI dynamics).

With the completion of the training mission, it was possible to complete the remaining steps to complete Mission 2, so the participants finished defining the activities in Trello, identifying in each ticket created the CM objective they were meeting and, later, defining the priorities for each activity. In the end, each employee had to include himself in some ticket(s) to develop it in the next mission, thus assuming responsibility for that activity. In this mission, both the creation and prioritization steps of the activities were ways of providing points to those involved in the performance worksheet.

The knowledge acquired in the training can be monitored at the time of creating the activities in the tool, as it was possible to verify the application of what was passed on in the training, in this case in theory for practical application. This training progress was evaluated on the Power Level Meter (a work product that has the ability to measure the power level of each hero according to actions taken in the mission).

With the completion of the Mission, it was possible to prepare the material to develop Mission 5. Thus, on 15.07.2021, Mission 5 was initially carried out with the provision of the performance obtained by the heroes in Mission 2 and in Mission 3 with the presentation of information collected in the Performance Worksheet (Google Worksheet).

Next, Mission 4 began, and the instructions for the procedures that would take place in the mission were initially presented. In this mission, those involved developed tickets with the activities that were agreed in Mission 2 and, during the development of the tickets, they had access to the special operations that were part of this mission, described in [34]. This mission required more time to develop, as there was a change in the time that was planned from just one to two days, 07.15.2021 and 07.22.2021.

In Mission 4, participants used the Infinity Gauntlet (glove-shaped work product) to collect the Infinity Gems, according to the rules and deliverables of the activities present on Trello. In the remote context, the gloves were made available to those involved on a web page created in the Google Sites tool without any jewelry, and when deliveries were made, the jewelry was inserted into the gloves on the website. Employees who experienced difficulties in any activity could request help during meetings held on Google Meet via chat, voice or video, or in Classroom under "Announce something to the class". To the participants who helped, there was the delivery of jewelry to compose the Glove, but the delivery was conditioned to the feedback of the help carried out in the Flag (work product used by the heroes to evaluate the actions that are carried out in their training and help, that is, it allows for a feedback of actions taken) in the Padlet tool, because only with positive feedback would the jewel be granted to the employee who provided the help. The employees who validated the completed tickets were also provided with jewelry.

Regarding the recognition of the activities performed, an activity was created in Google Classroom for those involved to assign another employee the Recognition Card for their performance in the activities. The activities developed in this mission were stipulated a time for delivery before the execution of the next mission.

The last day of execution (29.07.2021) was initially dedicated to the steps of recognition and performance rewards to those involved in the dynamics belonging to Mission 4. The recognition cards were made available to those involved on a web page in the Google sites tool and the rewards displayed on App-Sorteos.com (it's a free online application to make random draws in an easy and fun way). The rewards occurred according to the performance obtained by the heroes in Mission 4 with the presentation of the information collected in the Performance Worksheet (Google Worksheet) exposed in Mission 5.

Finally, Mission 6 took place with a brainstorming session, considering solutions applied to SPI problems to obtain feedback from those involved. A SWOT analysis was also carried out to obtain a clear and objective view of what are the strengths, weaknesses, opportunities and threats in relation to the strategies established in the SPI dynamics to those involved in the organizational context.

5.3 Evaluation

After the conclusion of the SPI dynamics, the necessary information was collected to carry out the evaluation of the results, using the Framework for gamification evaluation by Monteiro et al. [22]. For the evaluation, it was necessary to define the evaluation criteria, questions, indicators and metrics. The defined evaluation criteria were: C01) Performance, with a focus on productively participating in the proposed activities throughout the dynamic, making the necessary deliveries efficiently, C02) Satisfaction, to have their expectations met in the activities, C03) Awareness, being aware of the responsibilities and consequences of the actions taken, C04) Engagement, collaboratively and proactively participating in the proposed activities, always involved and committed to the necessary deliveries, C05) Participation, being present and efficiently participating in the proposed activities, C06) Understanding, effectively understanding the instructions provided during the implementation of the improvement and C07) Positive Involvement, participating and engaging in the proposed activities, acting with promptness, collaboration and recognition of the work carried out by the people who belong to the group.

Therefore, considering the gamified elements and strategies developed for the twenty SPI problems, and the criteria exposed above, 72 questions were elaborated, and for each SPI problem there could be one or more questions to investigate. To answer these questions, 43 indicators were developed, related to 9 metrics. To understand all the issues, indicators and metrics related to the analysis of gamification elements and, later, to SPI problems, the file available at (https://zenodo.org/record/6299232#.YhpKS-jMI2w) was generated.

The answers to these questions help to answer the main question of the study "Did the gamified approach help to solve problems or difficulties in the implementation of SPI?".

The information collected in the dynamics was documented in data collection and analysis procedures, where data collection instruments were defined (Performance worksheet, Video of meetings, satisfaction script and SWOT Analysis) and quantitative

data analysis procedures (data objective) and qualitative (subjective data) to answer the evaluation questions.

6 Data analysis

This section presents the data obtained from the use of the gamification evaluation framework in relation to SPI dynamics applied in the Experience Report of Laboratory. The analysis will be performed from each SPI problem.

6.1 Analysis of the problem 'Culture change in the organization'

For the problem of *Culture Change in the Organization*, 12 (twelve) questions were prepared to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, the 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the first question *(Q01 - Did the gamified approach promote joint participation of employees in activities regarding the analysis and definition of SPI problem solving strategies in the studied context?)*, we sought to analyze the criteria of **Performance (C01)** and **Participation (C05)** in the application of the element 'Build from scratch', considering both quantitative and qualitative data to obtain the result. Thus, the following deductive analyzes on criteria C01 and C05 were obtained:

- During Mission 2, all participants worked together in the activities of analysis and definition of strategies for the implementation of the desired improvement model, which favored a positive performance in the development of this demand. This is evidenced in the scores obtained, as the 7 (seven) participants reached the expected value in the activity of +30 points,
- It was observed in the moments developed in the dynamics that all the participants managed to develop the activities of analysis and definitions together, interacting to structure a backlog of activities that they considered necessary to achieve the improvement results.

Thus, the analysis carried out for the element 'Build from scratch' shows that the participants were able to work together, collaborating in the structuring of analysis activities and definitions of strategies that were established and adopted in the dynamics. Participation in the structuring process evidences the application and the expected result of the element 'Build from scratch'.

In the results of the application of the **'Narrative'** element, 3 (three) questions were analyzed *(Q02 - Did the gamified approach favor the employees' understanding of the necessary changes in the studied context?, Q03 - Did the employees identify necessary changes in the studied context? and Q04 - The employees made the necessary changes in the context studied?)*. In these questions, we sought to analyze the criteria of **Performance (C01)**, **Participation (C05)** and **Engagement (C04)**, considering only quantitative data to obtain the result. It is noteworthy that there was an analysis of data in each question, as the result of the application, from the element to the problem, corresponds

to the joint analysis of the results of these questions. This reasoning extends to the other elements that had more than one question analyzed. Thus, the following deductive analyzes on criteria C01, C05 and C04 were obtained:

- Participants were able to perform the necessary activities throughout the dynamic: in Mission 1, participants were able to obtain values in the range of 95 to 100 points, in Mission 2 the participants managed to obtain values in the range of 81 to 97 points, in Mission 3 they reached 90 points; in Mission 4 they managed to obtain values in the range of 150 to 220 points. It is noteworthy that there is a maximum value established only in missions 1, 2 and 3 equivalent to 100 points, as in Mission 4 there is no limit to the maximum amount of activities that the participant develops, as it depends on the demand established in the backlog of actions of organizational improvements. Therefore, even with oscillations in the values of the participants' scores, it is noteworthy that no participant was left without carrying out activities in the missions, so the realization of deliveries presupposes that there was an understanding of the employees about the necessary changes to achieve the improvement results,
- During the development of the missions, most participants were able to point out possible changes to improve the procedures adopted throughout the dynamics: in Mission 1 all participants provided suggestions, therefore, they scored in the mission, in Mission 2 only the participant H02 did not score, as he did not provide a suggestion, in Mission 3 there were no suggestions, as it is a mission focused on team training with guidance from the Senior Management representative who has more than 20 years of experience in software process improvement, providing training and consulting, in Mission 4 there were few suggestions, which can be justified by a more practical and interactive round in its development,
- The analyzed results involve the operations necessary to achieve the results in the context of the improvement present in Mission 4, in which all participants (H01, H02, H03, H04, H05, H06 and H07) managed to perform the activities present in Mission 4, obtaining respectively 210, 150, 210, 210, 190, 160 and 160 points (Total points per Operation). The fluctuations in the values of the participants' scores occurred because some performed activities that had a lower or higher value in relation to the others. The scores presented show that the participants did not fail to carry out the demands belonging to the activities backlog, that is, they remained engaged in fulfilling the necessary changes that were established in the mission's operations.

Thus, the analyzes carried out on the results of the 'Narrative' element show that the participants were able to identify and make the necessary changes in the context, this demonstrates that there was the development of demands for improvement, and this development was provided by guidelines and moments of incentives arranged in the scenario dynamics, which shows the application and expected result of the 'Narrative' element.

As for the application of the '**Tutoria**' element, 2 (two) questions were analyzed *(Q05 - Did the employees understand and participated in the guidelines regarding the heroes' action track? and Q06 - Were the employees satisfied with the instructions given?)*. In these questions, we sought to analyze the criteria for **Participation (C05)**,

Understanding (C06) and **Satisfaction (C02)**, considering quantitative and qualitative data to obtain the results. Thus, the following deductive analyzes on criteria C05, C06 and C02 were obtained:

- The analyzed results belong to Mission 3, in which all the participants were present, acting in a participatory way in the moments dedicated to the guidelines that appear in the action track, participation favored the expected score for this activity equivalent to +30 points,
- During the development of the missions, it was observed that the participants developed the activities necessary to achieve the improvement results, which demonstrates the understanding of the guidelines present in the action track, as the knowledge acquired in the training (Mission 3) was applied in practical moments from other missions, tracked on the Power Gauge,
- In the activity of signaling satisfaction with the training, carried out in Mission 3, only the participant H06 did not score in this measure, all others developed and positively signaled the training actions, thus obtaining the score granted for this activity of +30 points,
- Participants provided positive feedback on the training provided, this was evidenced by the results collected in the Satisfaction Roadmap, where some reported that training is essential for understanding the context of improvement, others highlighted the importance of having a person to instruct with a high level of experience in the context of SPI, as it facilitates even more the understanding of the knowledge necessary for the implementation of the model.

The analyzes carried out on the results of the 'Tutoria' element show that the participants understood the guidelines provided in the actions track and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. This result evidence the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, contributed to the participants in the development of the demands for established improvements.

Regarding the application of the '**Free Lunch**' element, 2 (two) questions were analyzed *(Q07 - Did the gamified approach engage employees in carrying out activities in the context studied? and Q08 - Were the employees satisfied with the gamified approach used?).* In these questions, we sought to analyze the criteria of **Performance (C01)**, **Engagement (C04)** and **Satisfaction (C02)**, considering quantitative and qualitative data to obtain the results. Thus, the following deductive analyzes on criteria C01, C04 and C02 were obtained:

- The scores obtained, in Mission 4, by the participants (H01, H02, H03, H04, H05, H06 and H07), respectively 210, 150, 210, 210, 190, 160 and 160 points (Total points per Operation), shows that they remained engaged in fulfilling what was expected in the operations present in Mission 4, since they were able to perform the activities, as they did not fail to carry out the demands belonging to the backlog of activities necessary to achieve the results in the context of improvement,

- According to information obtained in the SWOT Analysis, the participants reported being satisfied with the proposed dynamics, highlighting difficulties in understanding at the beginning of the dynamics (Mission 1), but which were clarified during the application. Participants also showed that the use of gamification in the context of heroes in the SPI scenario stimulates people's participation.

The analyzes carried out on the results of the 'Free Lunch' element show that the participants complied with the demands of the improvement model, developing the necessary activities, which were present in the activities backlog, aiming for the recognition and / or reward provided by the approach gamified, and even gave positive feedback to this strategy. The participants' search for recognition and / or reward resulting from the fulfillment of activities evidences the application and expected result of the 'Free Lunch' element.

As for the application of the **'Rockstar Effect'** element, only 1 (one) question (*Q09- Did the employees recognize the quality of their colleagues' work while carrying out the activities?*) was analyzed, considering the analysis of the **Positive Involvement (C07)** criterion in quantitative data and qualitative to obtain the results. Thus, the following deductive analyzes on criterion C07 were obtained:

- At the end of Mission 4, the participants recognized the work developed by their colleagues and also received recognition for the work done, this recognition is evidenced in the Recognition Cards delivered. In this dynamic, all participants received cards, but the participant who received the most was H04 with a total of 5 cards and those who received the least amount were participants H02 and H06 with only 1 card,
- It was observed that in the application of the recognition dynamics there was a positive involvement among the participants, as they provided feedback regarding the quality of the work developed by their colleagues, strengthening the appreciation and consequently the engagement in the work performed by the team, since all the participants had their work recognized, being praised for what they performed.

In the analysis carried out, the results of the 'Rockstar Effect' element show that there was recognition of the work developed among the participants, this was symbolized in the delivery of Cards with positive feedback in relation to the work performed. The recognition generated evidence application and expected result by the element 'Rockstar Effect'.

Regarding the application of the **'Glowing Choice'** element, 2 (two) questions were analyzed *(Q10 - Did the employees work together in the development of activities? and Q11 - Did working together make the development of activities possible?)*. In these questions, we sought to analyze the criteria of **Performance (C01)**, **Participation (C05)** and **Positive Involvement (C07)**, considering quantitative and qualitative data to obtain the results. Thus, the following deductive analyzes on criteria C01, C05 and C07 were obtained:

- In Mission 4, participants who requested help from another participant were H02, H03 and H07, which were able to work together and fulfill their demands, and participants who provided the help received +20 points for the assistance provided: H03 provided assistance received +20 points, H07 provided two aids and obtained + 40 points,
- It was observed in Mission 4 that participants H02, H03 and H07 managed, with the help provided by another participant, to develop their activities, since they provided satisfactory feedback from the help, so there was a positive involvement between the team members.

The analyzes carried out on the results of the 'Glowing Choice' element show that participants who requested help from another participant were able to work together and fulfill their demands, providing satisfactory feedback on the help provided. The strategy provided those involved with a resource to continue performing what was necessary to achieve the expected goals in times of difficulty, which shows the application and expected result of the 'Glowing choice' element.

For the application of the '**Appointments dynamics**' element, only 1 (one) question was analyzed *(Q12 - Was there an improvement in the participants' performance regarding the development of activities present in the dynamics through performance feedback?)* with the analysis of the **Performance (C01)**, **Awareness (C03)** and **Participation (C05)** criteria in quantitative data. Thus, the following deductive analyzes on criteria C01, C03 and C05 were obtained:

- Some participants had fluctuation in their performance in the rounds, some managed to increase their score, others reduced it: in Mission 1 the participants managed to obtain values in the range of 95 to 100 points, in Mission 2 the participants managed to obtain values in the range of 81 to 97 points, in Mission 3 they reached 90 points, in Mission 4 they managed to obtain values in the range of 150 to 220 points. However, it is noticeable that most of the participants became aware of improving their performance in the activities and consequently helped the team to fulfill the necessary deliveries.

In the analysis results for the 'Appointments dynamics' element, it is noticeable that when the score was shown to the participants, those with lower scores had a stimulus to improve the performance obtained in the missions, since the majority became aware and performed the activities to help the team, fulfilling the necessary deliveries, which demonstrates the application and result expected by the 'Appointments dynamics' element, as providing performance information made them proceed in order to improve their performance in the missions.

6.2 Analysis of the problem 'Lack of knowledge in software engineering'

For the problem of *Lack of Knowledge in Software Engineering*, 4 (four) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 5 (five) of the 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed *(Q13 - Did employees understand and participate in the guidelines regarding software engineering tutoring? and Q14 - Were employees satisfied with the software engineering guidelines passed?)*. In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Participation (C05)**, and **Understanding (C06)**, considering quantitative and qualitative data to obtain the results.

The deductive analyzes evidenced in the Questions Q05 and Q06 are based as data for the questions Q13 and Q14, since the tutoria in Software Engineering was inserted in the Action Track.

Therefore, the analyzes carried out on the results of the 'Tutoria' element demonstrate that the participants understood the guidelines and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. In these actions, the necessary knowledge was provided to develop the activities to achieve the results of the improvement. The participants' performance evidences the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, was applied by the participants in the development of the demands for established improvements.

For the application of the '**Progress Bars**' element, only 1 (one) question was analyzed *(Q15 - Did the software engineering tutoring help in the correct performance of the activities in the studied context? If not, why?)* with the analysis of the **Performance (C01)**, **Participation (C05)** and **Understanding (C06)** criteria in quantitative data. Thus, the following deductive analyzes on criteria C01, C05 and C06 were obtained:

- The accomplishment and the results obtained in the activities necessary to the context of the improvement, shows that there was an understanding of the employees about the knowledge necessary to perform the activities and achieve the improvement results. The performance worksheet is made available to the participants, with information on the types of activities and scores obtained. Activities required the application of knowledge acquired in training for their development, and all participants scored in this mission (Mission 4): participants (H01, H02, H03, H04, H05, H06 and H07) and their respective scores, 220, 160, 240, 220, 205, 170 and 215 points (Total Hero Points).

The results of the analysis of this element show that the participants were able to follow the progress of the level of knowledge acquired in the training, because in the practical moments, the participants were measured and provided feedback on the application of the acquired knowledge, from the fulfillment of the activities established in the missions. This strategy of measuring and providing performance monitoring evidence the application and the expected result of the 'Progress Bars' element.

As for the application of the '**Glowing choice**' element, only 1 (one) question *(Q16 - Did the gamified approach instigate help among employees in solving activities in the context studied in situations of doubts, lack of knowledge or expertise?)* was analyzed, considering the analysis of the criteria of **Performance (C01)**, **Participation (C05)** and **Positive involvement (C07)** in quantitative and qualitative data to obtain the results.

The deductive analyzes evidenced in the Questions Q10 and Q11 are based on data for the questioning Q16, since they deal with situations in which the participant finds it difficult to understand or perform the activities assigned to them in the dynamics in relation to the model, the tools used, lack of knowledge in software engineering or even lack of necessary technical knowledge.

The results of this element show that participants who requested help from another participant were able to work together and fulfill their demands, providing satisfactory feedback on the help provided. The strategy provided those involved with a resource to continue performing what was necessary to achieve the expected goals in times of difficulties due to the lack of necessary knowledge in software engineering, which shows the application and expected result of the 'Glowing choice' element.

6.3 Analysis of the problem 'Lack of understanding of stakeholder responsibilities'

For the problem of Lack of *Understanding of Stakeholder Responsibilities*, 5 (five) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 6 (six) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Narrative**' element, only 1 (one) question (*Q17 - Did the employees understand the functions of each role within the gamified approach explained?*) was analyzed, considering the analysis of the **Understanding (C06)** criterion in qualitative data to obtain the results. Thus, the following deductive analysis was obtained on criterion C06:

- It was observed in Mission 4 that the participants were able to develop the activities necessary to achieve the expected results in the context of the desired process improvement, as they did not fail to participate and comply with the deliveries of the demands, which demonstrates the understanding of the role that each one had to play to achieve the improvement results.

The analysis carried out on the results of the 'Narrative' element shows that the participants were able to understand the role they had to play in the SPI dynamics, considering the context of heroes, since each one developed their skills and competences in the activities in order to help achieve what is expected in implementing the improvement. The proposed scenario allowed the participants to understand the importance of their performance in the activities proposed in the dynamics, this evidences the application and expected result of the 'Narrative' element.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed *(Q18 - Did employees commit to playing the roles assigned to them? and Q19- Did employees engage in performing the roles assigned to them?).* In these questions, we sought to analyze the criteria of **Awareness (C03)** and **Engagement (C04)**, being considered qualitative data in the analysis. Thus, the following deductive analyzes on criteria C03 and C04 were obtained:

- It was observed in mission 4 that the participants were able to develop the activities necessary for the context of the desired process improvement, that is, they did not fail to participate in the delivery of demands, acting consciously to fulfill the activities present in the backlog, which demonstrates the understanding of the importance and commitment to fulfilling the necessary demands to perform,
- Participants reported, in the Satisfaction Roadmap, that the way in which the information was passed on clarified the responsibility structure of each one. And they pointed out as a positive factor, not having the imposition to develop a specific activity, allowing the participants to select to develop the activities that they had more affinity or even knowledge, generating in those involved a sense of responsibility in carrying out the activities. Others ones reported that the imposition of demands can cause people to become demotivated, and the way in which it was passed on in the dynamics made the participants more comfortable and engaged in carrying out the deliveries.

The results show that the participants understood the guidelines regarding responsibility and the importance of participation in the development of activities, as they did not fail to deliver the demands, acting consciously to fulfill what was established in the activities backlog. The participants provided positive feedback to the responsibility guidelines as they reported that there was no enforcement structure to develop the demands, each one worked on the activity they had the most skill or competence to perform. The orientation and understanding of responsibility evidences the application and the expected result of the 'Tutoria' element.

Regarding the application of the '**Glowing choice**' element, 2 (two) questions were analyzed *(Q20 - If there was low engagement in fulfilling roles, did the employees work as a team to compensate for this absence? and Q21 - Did working together allow the development of activities?)*, considering the analysis of the criteria of **Performance (C01)**, **Participation (C05)** and **Positive Involvement (C07)** in quantitative and qualitative data to obtain the results.

The deductive analyzes evidenced in the Questions Q10 and Q11 are based on data for the questioning Q20 and Q21, since they deal with situations in which the participant finds it difficult to understand or perform the activities assigned to them or assumed as responsibility in the dynamics in relation to the model.

The results of this element show that participants who requested help from another participant were able to work together and fulfill their demands, providing satisfactory feedback on the help provided. The strategy provided those involved with a resource to continue performing what was necessary to achieve the expected goals in times of difficulties due to the lack of understanding of the responsibilities in the SPI activities, which shows the application and expected result of the 'Glowing choice' element.

6.4 Analysis of the problem 'Lack of support tools'

For the problem of *Lack of Support Tools*, 6 (six) questions were elaborated to be answered, according to the application of the gamification elements mapped to address

this problem. In this problem, 5 (five) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

For the element '**Build from scratch**' 2 (two) questions *(Q22 - Did the gamified approach promote the joint participation of employees in the activities to propose suggestions for tools to be used in the context of SPI? and Q23 - In the gamified approach were obtained/collected suggestions for tools from employees to help in the context of SPI?)* were analyzed, and in these we sought to analyze the criteria of **Performance (C01)** and **Participation (C05)**, considering both quantitative and qualitative data to obtain the result. Thus, the following deductive analyzes on criteria C01 and C05 were obtained:

- It was observed in the development of the dynamics that the participants gave suggestions regarding tools, and these were always discussed by the team in order to verify the opinion of all those responsible for achieving the improvement.
- During the development of missions 1 and 2, most participants were able to suggest possible tools to improve the procedures adopted and achieve the expected results in the implementation of the improvement: in Mission 1 all participants provided suggestions, so everyone scored in these missions (+10 points), in Mission 2 the participants H02, H06 and H07 did not score, as they did not provide a suggestion, the others managed to obtain a good performance in this demand (+ 10 points).

The results of this element show that the participants were able to work together, collaborating with suggestions for tools to be adopted throughout the dynamic, these suggestions were discussed by the team in order to verify the relevance of use by all those responsible for achieving the improvement. Participation in the structuring process evidences the application and expected result of the 'Build from scratch' element.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed (*Q24 - Did the employees understand the guidelines regarding the tools used in the context of MPS? and Q25 - Were the employees satisfied with the instructions given?*). In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Participation (C05)** and **Understanding (C06)**, considering quantitative and qualitative data in the analysis.

The deductive analyzes evidenced in the Questions Q05 and Q06 are based as data for the questions Q24 and Q25, since the tutoring in Tools to support the context of improvement was inserted in the Action Track.

The results show that the participants understood the guidelines and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. In these actions, information was passed on in relation to the tools necessary to develop the improvement activities. The participants' performance evidences the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, was used in the handling of the tools during the development of the demands for established improvements.

As for the application of the '**Glowing choice**' element, 2 (two) questions were analyzed (*Q26 - Was there employee engagement in working as a team to compensate for the difficulty in using the tools necessary to carry out the activities? and Q27 - Working together enabled the development of activities?*), considering the analysis of the criteria

of **Performance (C01)**, **Participation (C05)** and **Positive involvement (C07)** in qualitative data to obtain the results.

The deductive analyzes evidenced in the questions Q10 and Q11 are based on data for the questioning Q26 and Q27, since they deal with situations in which the participant feels difficulty in understanding and handling the tools used in the activities to be developed in the dynamics in relation to the model.

The results of this element, according to the application already described, show that the participants were able to work together and fulfill their demands, providing satisfactory feedback on the help provided. The strategy provided those involved with a resource to continue performing what was necessary to achieve the expected objectives in times of difficulties due to the lack of understanding regarding the tools used to implement SPI activities, which shows application and expected result by the ' Glowing Choice' element.

6.5 Analysis of the problem 'Lack of / Little commitment from top management'

For the problem of *Lack of / Little Commitment of Top Management*, 3 (three) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 4 (four) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Narrative**' element, only 1 (one) questioning (Q28 - Do senior management representatives understand the importance of commitment to their role within the explained gamified approach?) was analyzed, considering the analysis of the criteria for **Participation (C05)** and **Understanding (C06)** in qualitative data to obtain the results. Thus, the following deductive analyzes on criteria C05 and C06 were obtained:

- The senior management representative was present, participating and accompanying the team in missions 1, 2, 3. This demonstrates the understanding of the importance in relation to their participation and commitment in the approach with the team, being noticeable that their presence generated a greater commitment of participants regarding the development of demands.

The analysis carried out on the results of the 'Narrative' element shows that there was participation and monitoring of the senior management representative, in the moments of guidance and support to the team in the missions, demonstrates the understanding of the importance in relation to their participation and commitment in the approach with the team. Therefore, his presence and performance strengthened the relevance and commitment of the implementation of the improvement to the other participants, this evidences the application and expected result of the 'Narrative' element.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed (*Q29 - Were senior management representatives aware of the benefits that their work with the team would promote to the gamified approach? and Q30 - Top management representatives committed to performing and fulfilling responsibility for commitment to the role played?*). In these questions, we sought to analyze the criteria of **Awareness (C03)** and

Engagement (C04), being considered qualitative data in the analysis. Thus, the following deductive analyzes on criteria C03 and C04 were obtained:

- It was observed in the gamified approach that there was an understanding and awareness of the benefits caused by the performance and commitment of the Senior Management Representative in the approach with the team, since he was present, participating and accompanying the team in missions 1, 2, 3. This demonstrates the understanding of the benefits caused by their participation and commitment in the approach, being noticeable that their presence generated a greater commitment of the participant in the development of demands,
- Participants reported, in the Satisfaction Guide, that the participation of senior management was extremely important for the dynamics, as it was possible to see them working together with the team, which generated motivation for the group. This performance of the representative further highlighted to the team the importance of what they were developing for the organizational context.

The results show that the senior management representative was present, participating and accompanying the team in the missions, which emphasized the commitment to support the team to achieve the expected results. This demonstrates the understanding of the benefits caused by their participation and commitment to the approach with the team. The team reported that the representative's involvement generated more motivation for the group. Therefore, the understanding, commitment and performance of the senior management representative in the missions evidences the application and the expected result of the 'Tutoria' element.

6.6 Analysis of the problem 'Little support from employees'

For the problem *Little Support from Employees*, 7 (seven) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 6 (six) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Narrative**' element, only 1 (one) question (*Q31 - Did employees understand the importance and benefits of the SPI context, in which commitment to the role they assume within the explained gamified approach is essential?*) was analyzed, considering the analysis of **Engagement (C04)** and **Understanding (C06)** criteria in qualitative data to obtain the results. Thus, the following deductive analyzes on criteria C04 and C06 were obtained:

- It was observed that in missions 1, 2, 3 and 4 the participants developed the necessary activities to achieve the expected results in the desired process improvement, the development of these activities demonstrates that there was an understanding of the importance and commitment to fulfilling the necessary demands in the SPI context.

The analysis performed on the results of the 'Narrative' element demonstrates that the participants developed the necessary activities to achieve the expected results in the

context of the desired process improvement, which demonstrates the understanding regarding the importance of their participation and commitment in the gamified approach of heroes, which required a collective effort to fulfill the demands established in the approach. Therefore, the context of the approach contributed to the understanding of the relevance of each one's performance and the commitment to the implementation of the improvement for the participants, this evidences application and expected result by the 'Narrative' element.

In the application of the '**Tutoria**' element, 3 (three) questions were analyzed (*Q32 - Did the employees understand, in the guidelines passed on, the importance of commitment to the role they assume within the gamified approach to achieve improvement?, Q33 - The employees committed to performing and fulfill the responsibility regarding the commitment to the role played? and Q34 - Were the employees satisfied with the instructions given?*). In these questions, we sought to analyze the criteria of **Performance (C01)**, **Satisfaction (C02)**, **Engagement (C04)**, **Participation (C05)** and **Understanding (C06)** considering quantitative and qualitative data in the analysis. Thus, the following deductive analyzes on criteria C01, C02, C04, C05 and C06 were obtained:

- It was observed in Mission 4 that the participants understood and managed to develop the activities structured in this mission with the expected commitment, as they did not fail to participate in the delivery of demands, which demonstrates the understanding of the role that each one had to play to achieve the results of improvement,
- The realization of deliveries presupposes that there was an understanding of the responsibilities and commitment to the role played, since the demands in Mission 4 were fulfilled with the expected and necessary commitment in the context of SPI: the participants (H01, H02, H03, H04, H05 , H06 and H07) scored, respectively, 210, 150, 210, 210, 190, 160 and 160 points (Total points per Operation),
- In the results obtained in Mission 3, only the participant H06 did not score in this measure, the others developed and positively signaled the training actions, obtaining a score of +30 points for this activity,
- Participants provided positive feedback to the moments of guidance and training, this was evidenced by the use of the Satisfaction Roadmap, where some reported that training is essential for understanding the improvement, and consequently, motivating support in the context of the improvement implementation.

The results show the understanding of the guidelines provided to the participants in relation to responsibility and the importance of acting in the development of activities, as they did not fail to deliver the demands, acting consciously to fulfill the established activities. It is noteworthy that the participants provided positive feedback to the responsibility guidelines. Therefore, the application and the expected result of the 'Tutoria' element are evidenced in the guidelines, understanding of the responsibilities and performance of those involved in the approach.

Regarding the application of the '**Free Lunch**' element, 2 (two) questions were analyzed (*Q35 - Did the gamified approach engage employees in the commitment and fulfillment of activities in the context studied? and Q36 - Were the employees satisfied with the gamified approach used?*). In these questions, we sought to analyze the criteria

of **Performance (C01)**, **Satisfaction (C02)** and **Engagement (C04)**, considering quantitative and qualitative data to obtain the results.

The deductive analyzes evidenced in the questions Q07 and Q08 are based on data for the questioning Q35 and Q36, since in these questions the engagement and satisfaction of the participants to fulfill the activities are investigated, in order to acquire rewards in the context of the dynamics.

The analyzes carried out on the results of the 'Free Lunch' element show that the participants complied with the demands of the improvement model, developing the necessary activities, in order to have the recognition and / or reward provided by the gamified approach, and also provided feedback positive for this strategy. The participants' search for recognition and / or reward based on the fulfillment of activities evidences the application and expected result of the 'Free Lunch' element.

In the application of the '**Achievement Symbols**' element, only 1 (one) question (*Q37 - Did the employees recognize the quality of work and commitment of their colleagues during the performance of the activities?*) was analyzed, considering the analysis of the criterion of **Positive involvement (C07)** in quantitative and qualitative data to obtain the results. Thus, the following deductive analysis was obtained on criterion C07:

- At the end of Mission 4, the participants recognized the work developed by their colleagues and were also recognized for the work carried out, this recognition is evidenced in the Recognition Cards delivered, which portray symbols that are conquered by the recognition of the work, all participants received cards, however, the participant who received the most was H04 with a total of 5 cards and those who received the least amount were participants H02 and H06 with only 1 card,
- It was observed that in the application of the dynamics, the delivery of the achievement symbols considering recognition of the work, generated positive involvement among the participants, as they provided feedback regarding the quality of the work developed by their colleagues, strengthening the appreciation and consequently the engagement in the work performed by the team.

The analysis performed on the results in the element shows that there was recognition of the work developed among the team members, symbolized in the delivery of recognition cards with positive feedback related to the quality of the work performed by these members. The attribution of the recognition card for the work developed shows application and expected result by the 'Achievement Symbols' element.

6.7 Analysis of the problem 'Employee turnover'

For the problem *Employee Turnover*, 6 (six) questions were elaborated to be answered, according to the application of the gamification elements mapped to deal with this problem. In this problem, 6 (six) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Tutoria**' element, 3 (three) questions were analyzed (*Q38 - Did the employees understand the importance of the training carried out for the im-*

provement of technical knowledge that consequently favor the achievement of the expected results in the SPI implementations?, Q39 - The employees are committed and were able to perform the necessary activities during the SPI implementation? and Q40 - Were the employees satisfied with the training opportunities provided?). In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Engagement (C04)**, **Participation (C05)** and **Understanding (C06)** considering quantitative and qualitative data in the analysis.

The deductive analyzes evidenced in the questions Q32, Q33 and Q34 are based as data for the questioning Q38, Q39 and Q40, since in these questions they are asked about the understanding of the importance of the training provided, as well as the engagement and satisfaction of the participants in carrying out the activities present in the context of the dynamics, in this case fundamental to avoid the rotation of the people involved in the implementation.

The results show that the participants were able to understand the guidelines provided and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. The knowledge provided motivated the participation and commitment in the development of activities, as they did not fail to make the necessary deliveries, remaining until the end of the application of the approach. The participants' performance evidences the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, was applied by the participants in the development of the demands for established improvements.

Regarding the application of the '**Free Lunch**' element, only 1 (one) question was analyzed (*Q41 - Did the gamified approach engage employees to maintain commitment and performance in the necessary activities during the implementation of SPI?*). In this questioning, we sought to analyze the criteria of **Performance (C01)** and **Engagement (C04)**, considering quantitative data to obtain the results. Thus, the following deductive analysis on criteria C01 and C04 was obtained:

- The scores obtained, in Mission 4, by the participants (H01, H02, H03, H04, H05, H06 and H07), respectively 220, 150, 240, 220, 205, 170 and 215 points (Total Hero points), shows that the participants remained engaged in fulfilling what was expected in the activities present in Mission 4, since they were able to perform the activities, as they did not fail to carry out the demands belonging to the backlog of activities necessary to achieve the results in the context of improvement and consequently obtain recognition and reward for the work developed.

The analyzes carried out on the application of the 'Free Lunch' element show that the participants complied with the demands of the improvement model, developing the necessary activities with commitment, as they did not fail to carry out the demands present in the activities backlog, aiming for recognition and / or reward provided by the gamified approach, remaining until the end of the application of the SPI dynamics and still giving positive feedback to this strategy. The participants' search for recognition and / or reward resulting from the fulfillment of activities evidences the application and expected result of the 'Free Lunch' element.

As for the application of the '**Rockstar Effect**' element, only 1 (one) question (*Q42 - Did the employees recognize the commitment and performance of the activities of their colleagues while carrying out the activities?*) was analyzed, considering the analysis of the criterion of **Positive Involvement (C07)** on quantitative and qualitative data to obtain the results.

The deductive analyzes evidenced in the question Q09 are based on data for the questioning Q42, since in these questions the commitment to recognize the work performed among the team members is investigated.

In the analysis carried out on the results of the 'Rockstar Effect' element, they show that there was recognition of the work developed among the participants, symbolized in the delivery of Cards with positive feedback in relation to the work performed, the initial explanation of this strategy motivated the realization of demands and contributed to the permanence of the participants until the end of the application of the SPI dynamics. The recognition generated evidences application and expected result by the element 'Rockstar Effect'.

In the application of the '**List of rewards / lottery**' element, only 1 (one) question (*Q43 - Were the employees satisfied with the gamified approach used?*) was analyzed, considering the analysis of the **Satisfaction (C02)** criterion in qualitative data. Thus, the following deductive analysis was obtained on the C02 criterion:

- According to information obtained in the SWOT analysis, participants reported being satisfied with the dynamic proposal of recognition and rewards for the work developed by employees. Participants also showed that the use of gamification in the context of heroes in the SPI scenario stimulates people's participation.

The results show that the participants reported being satisfied with the rewards strategy provided by the gamified approach, since this strategy motivated the fulfillment of demands and contributed to the permanence of the participants until the end of the application of the SPI dynamics, which evidences the application and result expected by the 'List of rewards / lottery' element.

6.8 Analysis of the problem 'Lack of / Little qualified human resources'

For the problem *Lack of / Little Qualified Human Resources*, 4 (four) questions were created to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 6 (six) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed (*Q44 - Did the employees understand the guidelines given to qualify the knowledge necessary for the SPI context? and Q45 - The employees were satisfied with the guidelines provided during the qualification moments regarding the knowledge needed in the context of SPI?*). In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Participation (C05)** and **Understanding (C06)** considering quantitative and qualitative data in the analysis.

The deductive analyzes evidenced in the questions Q05 and Q06 are based as data for the questions Q44 and Q45, since they show the understanding and satisfaction of

the guidelines present in the Action Track, aimed at the qualification of those involved in the implementation.

The results show that the participants were able to understand the guidelines and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. In these actions, the necessary knowledge was provided to develop the activities to achieve the results of the improvement. The participants' performance evidences the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, was applied by the participants in the development of the demands for established improvements.

For the application of the ' **Progress Bars** ' element, only 1 (one) question was analyzed (*Q46 - Did the guidelines provided help in the correct performance of activities in the context of SPI? If not, why?*) with the analysis of the **Performance (C01)** and **Awareness (C03)** criteria in quantitative data.

The deductive analyzes evidenced in Q15 are based on data for the questioning C46, which deal with whether the guidelines and training helped in carrying out the activities necessary to implement the improvement.

The results of the analysis of this element show that the participants were able to follow the progress of the level of knowledge acquired in the training, because in the practical moments, the participants were measured and provided feedback on the application of the acquired knowledge, from the fulfillment of the activities established in the dynamics of gamification. This strategy of measuring and providing performance monitoring evidences the application and the expected result of the 'Progress Bars' element.

As for the application of the '**Glowing choice**' element, only 1 (one) question (*Q47 - Did the gamified approach instigate help among employees to develop activities in the context of SPI in situations of doubts and lack of knowledge?*) was analyzed, considering the analysis of the **Performance (C01)**, **Participation (C05)** and **Positive Involvement (C07)** criteria in quantitative and qualitative data to obtain the results.

The deductive analyzes evidenced in the questions Q10 and Q11 are based on data for the questioning Q47, since they deal with situations in which the participant finds it difficult to understand or perform the activities assigned to them in the dynamics in relation to the model.

The results of this element show that participants who requested help from another participant were able to work together and fulfill their demands, providing satisfactory feedback on the help provided. The strategy provided those involved with a resource to continue performing what was necessary to achieve the expected goals in times of difficulties due to the lack of necessary knowledge in software engineering, which shows the application and expected result of the 'Glowing choice' element.

6.9 Analysis of the problem 'Focus on certification instead of focusing on improvement'

For the problem Focus on *Certification instead of Focus on Improvement*, 3 (three) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 4 (four) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Narrative**' element, only 1 (one) question (*Q48 - Did the employees understand the benefits resulting from an SPI implementation for the development of their demands in the organizational routine, acting with commitment in the delivery of their activities?*) was analyzed, considering the analysis of **Engagement (C04)** and **Understanding (C06)** criteria in qualitative data to obtain the results. Thus, the following deductive analysis on criteria C04 and C06 was obtained:

- It was observed during the development of the missions that there was an understanding of the benefits and a commitment to fulfilling the necessary demands in the context of SPI, due to the participants having developed the necessary activities to achieve the expected results in the desired process improvement.

The analysis carried out on the results of the 'Narrative' element shows that the participants developed the activities necessary to achieve the expected results in the context of the desired process improvement, so the realization of the demands for improvement demonstrates that there was an understanding of the benefits and the importance of adopting the model. It is noteworthy that the development of demands was provided by guidelines and moments of incentives provided in the scenario of the SPI dynamics, which shows application and expected result by the 'Narrative' element.

For the element '**Build from scratch**' 2 (two) questions (*Q49 - Did the gamified approach promote the joint participation of employees in proposing suggestions for activities and points for improvement to be used in the context of SPI? and Q50 - In the gamified approach were obtained /suggestions collected from employees to help the context of SPI?*) were analyzed, and in these we sought to analyze the criteria of **Performance (C01)** and **Participation (C05)** considering both quantitative and qualitative data to obtain the result. Thus, the following deductive analyzes on criteria C01 and C05 were obtained:

- It was observed in the development of the dynamics that the participants gave suggestions in relation to new procedures and points of improvement that could be incorporated in the organizational context of the laboratory to achieve the improvement,
- During the development of the missions, the participants were able to suggest possible strategies to improve the adopted procedures and achieve the expected results in the implementation of the improvement: in Mission 1 all participants provided suggestions, therefore, they scored in the mission, in Mission 2 only the participant H02 did not score, as he did not provide a suggestion, in Mission 3 there were no suggestions, as it is a mission focused on team training with guidance from the Sen-

ior Management representative who has more than 20 years of experience in software process improvement, providing training and consulting, and in Mission 4 there were few suggestions, which can be justified by a more practical and interactive round in its development.

The results of this element show that the participants were able to work together, collaborating in the establishment of the activities that were adopted in the dynamics. Participation in the structuring process evidences the application and expected result of the 'Build from scratch' element of involving them in the development stage to clarify the benefits and increase ownership in the process, in order to facilitate the implementation of the improvement.

6.10 Analysis of the problem 'Lack of government incentive'

In the application of the '**Elitism**' element to the problem Lack of Governmental Incentive only 1 (one) question was analyzed (*Q51 - Did the gamified approach promote visibility and contribute with external incentives to the organization's context?*) with the analysis considering only 2 (two) of 7 (seven) evaluation criteria, **Engagement (C04)** and **Positive Involvement (C07)**, in qualitative data. Thus, the following deductive analysis on criteria C04 and C07 was obtained:

- Participants created marketing strategies to disseminate information about the work developed by the group, this dissemination promoted a positive interaction with external people, who showed interest in what is developed by the laboratory group, with likes, views, comments and interest in participating in the laboratory. group.

The results of applying this element show that the participants contributed to the development of strategies within the organizational context to help promote the visibility, which is expected by the application of the 'Elitism' element. Thus, the dissemination structured by the group favored a positive interaction with external people, attracting the interest of people to participate or contribute to the work developed by the group.

6.11 Analysis of the problem 'Lack of knowledge of the importance of models by the market'

The problem *Lack of Knowledge of the Importance of Models by the Market* analyzed, as well as the questioning Q51 factors directed to external perspectives of the work developed in the organizational context, thus, there was only the application of the 'Elitism' element in the questioning (*Q52 - Did the gamified approach promote visibility and contribute with external incentives to the organization's context?*) with the analysis considering only 2 (two) of 7 (seven) evaluation criteria, **Engagement (C04)** and **Positive involvement (C07)**, in qualitative data. Thus, the following deductive analysis on criteria C04 and C07 was obtained:

- Participants created strategies to publicize the work developed in line with the improvement model, which allowed for the recognition of the work developed by the group by people outside the laboratory. Another factor that led to recognition was the amount of work developed and disseminated by the group, and even the form of work followed by the group's members in the laboratory.

The results of this element show that the participants created strategies to disseminate the work developed, adhering to the improvement model, to promote visibility, a factor that is expected in the application of the 'Elitism' element. The dissemination strategies created contributed to the recognition and interest of external people in relation to what is developed in the group's work routine.

6.12 Analysis of the problem 'Reduction in consulting hours as a way to reduce costs'

The problem *Reduction in Consulting Hours as a Way of Reducing Costs* analyzed only the application of the '**Narrative**' element in a questioning (*Q53 - Organization's stakeholders understood the importance of carrying out the objectives or practices present in the improvement model, acting in a way that meet and develop what is expected to achieve the results in the model?*) with the analysis considering only 2 (two) of 7 (seven) evaluation criteria, **Awareness (C03)** and **Understanding (C06)**, in qualitative data. Thus, the following deductive analysis on criteria C03 and C06 was obtained:

- It was observed during the development of the missions that there was an understanding of the importance of implementing the improvement practices, since the participants were aware of acting in a committed way in fulfilling the necessary demands in the context of SPI, evidenced in the development and delivery of the activities necessary to achieve the expected results in the desired process improvement.

The results of this element show that the participants developed the necessary activities to achieve the expected results in the desired process improvement, the development of these activities demonstrates the understanding of the importance of implementing and that there was a commitment to fulfill the demands present in the gamified approach. It is noteworthy that the development of demands was provided by guidelines and moments of incentives provided in the scenario of the SPI dynamics, which shows application and expected result by the 'Narrative' element.

6.13 Analysis of the problem 'Lack of / Few projects to validate an improvement program'

The problem *Lack of / Few Projects to Validate an Improvement Program* analyzed only the application of the '**Tutoria**' element in a questioning (*Q54 - The collaborators understood the importance and the need to develop and structure consistent projects / services to contribute to the implementation of SPI?*) with the analysis considering only 2 (two) of 7 (seven) evaluation criteria, **Awareness (C03)** and **Understanding (C06)**,

in qualitative data. Thus, the following deductive analysis on criteria C03 and C06 was obtained:

- It was observed during the development of the missions that there was an understanding of the importance of structuring and implementing projects / services in order to contribute to the improvement practices, as the participants acted consciously and committed to fulfilling the necessary demands in the context of SPI, evidenced in the development and delivery of the activities necessary to achieve the expected results in the desired process improvement.

The results of this element show that the participants understood the guidelines and the importance of establishing necessary demands to achieve the expected results in the desired process improvement. The participants' performance in the SPI approach evidences the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, was applied by the participants in the development of the demands for established improvements.

6.14 Analysis of the problem 'Bureaucracy in improvement programs'

For the problem of *Bureaucracy in Improvement Programs*, 4 (four) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 4 (four) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Narrative**' element, only 1 (one) question (*Q55 - Did the employees understand the relevance of implementing the improvement and the need to adopt the necessary measures in the context of the model to be implemented?*) was analyzed, considering the analysis of the **Understanding (C06)** criterion in qualitative data to obtain the results.

The deductive analyzes evidenced in the question Q53 are based on data for the questioning Q55, since they deal with situations related to the understanding of those involved regarding the understanding of the need to implement the necessary practices in relation to the improvement model.

The analysis carried out on the results of the 'Narrative' element demonstrates that the participants developed the necessary activities to achieve the expected results in the context of the improvement, this demonstrates that there was an understanding of the benefits and importance of adopting the model. It is noteworthy that the motivation for the development of demands was provided by guidelines and moments of incentives and clarifications provided in the scenario of the SPI dynamics, which shows the application and expected result of the 'Narrative' element.

For the '**Build from scratch**' element, a questioning (*Q56 - Did the gamified approach provide a collaborative environment, in which employees could contribute by providing strategies to help achieve the expected results in the context of improvement?*) was analyzed, in which we sought to to analyze the **Performance (C01)** and **Participation (C05)** criteria, considering the quantitative data to obtain the result. Thus, the following deductive analysis on criteria C01 and C05 was obtained:

- The performance worksheet shows that during the development of the missions, the participants were able to suggest possible strategies to structure and contribute to the achievement of the expected results in the implementation of the improvement: in Mission 1 all participants provided suggestions, therefore, they scored in the mission, in Mission 2 only the participant H02 did not score, as he did not provide a suggestion, in Mission 3 there were no suggestions, as it is a mission focused on team training with guidance from the Senior Management representative who has more than 20 years of experience in software process improvement, providing training and consulting, and in Mission 4 there were few suggestions, which can be justified by a more practical and interactive round in its development.

The results of this element show that the participants were able to work collaboratively in establishing the activities that were adopted in the dynamics. Participation in the structuring process evidences the application and expected result of the 'Build from scratch' element of involving them in the development stage to clarify the benefits and increase ownership in the process, providing an environment of contribution and not obligations, in the to facilitate the implementation of the improvement.

In the application of the '**Tutoria**' element, only 1 (one) question was analyzed (*Q57 - Did the employees understand, in the guidelines passed on, the need and importance of adopting and aligning the organization's activities to the context of the improvement program?*). In this questioning, we sought to analyze the criteria of **Engagement (C04)** and **Understanding (C06)** being considered qualitative data in the analysis. Thus, the following deductive analysis on criteria C04 and C06 was obtained:

- It was observed during the development of the missions that there was an understanding of the importance of structuring procedures and practices in the context of improvement, as the participants were committed to fulfilling the demands necessary for the SPI context, evidenced in the development and delivery of the activities necessary for achieve the expected results in the desired process improvement.

The results show that the participants were able to understand the guidelines related to the needs to implement the improvements and the importance of being committed to the development of activities, as they did not fail to deliver the demands, acting consciously to fulfill what was established in the backlog. of activities. Therefore, the application and the expected result of the 'Tutoria' element are evidenced in the guidelines, understanding of needs and in the performance obtained by those involved in the approach.

In the '**Mystery boxes**' element, only 1 (one) question was analyzed (*Q58 - Did the dynamics of recognition and rewards resulting from the performance and delivery of activities promote the performance and participation of the employee in the implementation of the improvement?*), in which we sought to analyze the **Performance (C01)** and **Participation (C05)** criteria, considering the quantitative data to obtain the result. Thus, the following deductive analysis on criteria C01 and C05 was obtained:

- The scores obtained in Mission 4, in which the moments of recognition and rewards occurred by the participants (H01, H02, H03, H04, H05, H06 and H07), respectively

220, 150, 240, 220, 205, 170 and 215 points (Total Hero points), shows that the participants remained engaged in fulfilling what was expected in the activities present in Mission 4, since they were able to perform their activities, carrying out the demands belonging to the backlog of activities necessary to achieve the results in the context of improvement and consequently have the possibility of being recognized and rewarded for the work carried out.

The results of this element show that moments of recognition and / or rewards were provided to the participants for the work developed, this strategy contributed to the fulfillment of the demands of the improvement model, as the participants did not fail to carry out the deliveries present in the activities backlog, aiming for the recognition and / or reward provided by the gamified approach. Therefore, the participants' search for recognition and/or reward resulting from the fulfillment of activities evidences the application and expected result of the 'Mystery Boxes' element.

6.15 Analysis of the problem 'Continuity of team engagement in the defined process'

For the *Continuity of Team Engagement in the Defined Process* problem, 3 (three) questions were created to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, 5 (five) of 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the ' **Tutoria** ' element, 2 (two) questions were analyzed (*Q59 - Did the training dynamics and guidance provided to employees contribute to the understanding and engagement of employees in the development and achievement of expected results in the context of SPI? and Q60 - Do employees satisfied with the instructions given?*). In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Engagement (C04)**, **Participation (C05)** and **Understanding (C06)** considering quantitative and qualitative data in the analysis.

The deductive analyzes evidenced in the questions Q05 and Q06 are based as data for the questions Q59 and Q60, since they show the understanding and satisfaction of the guidelines present in the Action Track, aimed at the qualification of those involved and continuity in the work developed in the implementation.

The results show that the participants were able to understand the guidelines related to maintaining responsibility, participation and commitment in the development of activities, as they did not fail to deliver the demands, acting consciously to fulfill what was established in the activities backlog. It is noteworthy that the participants provided positive feedback to the guidelines of responsibilities which must be integrated in order to maintain the improvements in the organizational context. Therefore, the application and the expected result of the 'Tutoria' element are evidenced in the guidelines, understanding of the responsibilities and performance of those involved in the approach.

For the application of the '**Appointments dynamics**' element, only 1 (one) question was analyzed (*Q61 - Provide performance feedback to employees, did it contribute to the realization and adjustments of improvements in the activities performed by those*

involved?) with the analysis of the **Performance (C01)** and **Participation (C05)** criteria in quantitative data. Thus, the following deductive analysis on criteria C01 and C05 was obtained:

- Participants were able to monitor their performance in the rounds, in the Performance Worksheet, some managed to increase their score, others reduced it: in Mission 1 participants managed to obtain values in the range of 95 to 100 points, in Mission 2 the participants managed to obtain values in the range of 81 to 97 points, in Mission 3 they reached 90 points, in Mission 4 they managed to obtain values in the range of 150 to 220 points. However, it is noticeable that most of the participants became aware of improving their performance in the activities and consequently helping the team to fulfill and continue the improvement strategies.

In the analysis results for the 'Appointments dynamics' element, it is noticeable that when showing the score to the participants, those with lower scores had a stimulus to improve the performance obtained in the missions, since most became aware and performed the activities to help the team, fulfilling the necessary deliveries. Therefore, the strategy of providing performance information can contribute to the engagement of participants in maintaining or improving their performance in the activities, which highlights the application and expected result of the 'Appointments dynamics' element.

6.16 Analysis of the problem 'Lack of / Little knowledge of models by employees'

For the problem *Lack of / Little Knowledge of Models by Employees*, 4 (four) questions were elaborated to be answered, according to the application of the gamification elements mapped to address this problem. In this problem, the 7 (seven) evaluation criteria defined in the context of dynamics were used in the analysis.

In the application of the '**Narrative**' element, a questioning was used (*Q62 - Did the employees understand the importance of knowing the practices present in the improvement model, in order to develop what is expected to achieve the results in the model?*) with the analysis considering the evaluation criteria for **Awareness (C03)**, **Engagement (C04)** and **Understanding (C06)** in qualitative data.

The deductive analyzes evidenced in the question Q53 are based on data for the questioning Q62, since they deal with situations related to the understanding of those involved regarding the understanding of the need and importance of implementing the necessary practices in relation to the improvement model.

The results of this element show that the participants developed the necessary activities to achieve the expected results in the desired process improvement, so the realization of the improvement demands demonstrates that there was an understanding of the benefits and the importance of adopting the quality model. It is noteworthy that the development of demands was provided by guidelines and moments of incentives provided in the scenario of the SPI dynamics, which shows application and expected result by the element 'Narrative'.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed (*Q63 - Did the employees understand the guidelines regarding the improvement model used in the context of SPI? and Q64 - Were the employees satisfied with the instructions*

given?). In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Participation (C05)** and **Understanding (C06)**, considering quantitative and qualitative data in the analysis.

The deductive analyzes evidenced in the questions Q05 and Q06 are based as data for the questions Q63 and Q64, since they show the understanding and satisfaction of the guidelines present in the Action Track, related to the improvement model used in the implementation.

The results show that the participants were able to understand the guidelines and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. In these actions, the necessary knowledge was provided to develop the activities to achieve the results of the implementation of the improvement model. The participants' performance evidences the application and the expected result of the 'Tutoria' element, since the knowledge obtained, in the moments of orientation, was applied by the participants in the development of the demands for established improvements.

Regarding the application of the '**Glowing choice**' element, a questioning was analyzed (*Q65 - Did the gamified approach instigate help among employees in the development of activities in the context of SPI in situations of doubts and lack of knowledge regarding the improvement model adopted?*), considering the analysis of the criteria of **Performance (C01)**, **Participation (C05)** and **Positive involvement (C07)** in qualitative data to obtain the results.

The deductive analyzes evidenced in the questions Q10 and Q11 are based on data for the questioning Q65, since they deal with situations in which the participant finds it difficult to understand or perform the activities related to the improvement model used.

The results of this element show that the participants worked together fulfilling their demands, and provided satisfactory feedback on the help provided. The strategy provided those involved with a resource to continue performing what was necessary to achieve the expected objectives in times of difficulties due to the lack of knowledge necessary to implement the improvement model, which shows the application and expected result of the 'Glowing choice' element.

6.17 Analysis of the problem 'Different interpretations in relation to the models'

For the problem *Different Interpretations in Relation to the Models*, 3 (three) questions were elaborated to be answered, according to the application of the mapped gamification elements, and only 3 (three) of 7 (seven) evaluation criteria defined for the dynamics context were used.

In the application of the '**Narrative**' element, a questioning was used (*Q66 - Did the dynamics used in the approach provide necessary information to employees to understand the practices present in the improvement model?*) with the analysis only of the **Understanding (C06)** evaluation criterion in data qualitative. Thus, the following deductive analysis was obtained on criterion C06:

- It was observed during the development of the missions that the participants were able to develop the necessary activities to achieve the expected results in the desired

process improvement. Therefore, the development of these activities demonstrates that the strategies present in the dynamics made it possible to understand, develop and fulfill the demands necessary for the SPI context.

The results of this element show that there was an understanding of the benefits and importance of adopting the quality model by the participants, as they developed the necessary activities to achieve the expected results in the desired process improvement. This positioning was provided by guidelines, clarifications and moments of incentives provided in the scenario of the SPI dynamics contributed to the development of demands, which evidences the application and expected result of the 'Narrative' element.

In the application of the '**Tutoria**' element, 2 (two) questions were analyzed (*Q67 - Did the employees understand the guidelines regarding the improvement model used in the context of SPI? and Q68 - Were the employees satisfied with the instructions given?*). In these questions, we sought to analyze the criteria of **Satisfaction (C02)**, **Participation (C05)** and **Understanding (C06)**, considering quantitative and qualitative data in the analysis.

The deductive analyzes evidenced in the questions Q05 and Q06 are based as data for the questions Q67 and Q68, since they show the understanding and satisfaction of the guidelines present in the Action Track, related to the improvement model used in the implementation .

The results show that the participants were able to understand the guidelines and the importance of participating in the training actions, since they were present and gave positive feedback on these actions. In these actions, the necessary knowledge was provided to develop the activities to achieve the results of the implementation of the improvement model, thus providing what was expected by the 'Tutoria' element, since the knowledge obtained in the moments of orientation, was efficiently applied by the participants in the development of demands.

6.18 Analysis of the problem 'Lack of consistent project portfolio planning'

For the problem *Lack of Consistent Project Portfolio Planning*, only 1 (one) question (*Q69 - Did the collaborators understand the importance and need to develop and structure consistent projects / services that can contribute to the context of improvement implementations?*) of the application of the '**Tutoria**' element was analyzed, considering only the evaluation criteria of **Awareness (C03)** and **Understanding (C06)** in quantitative and qualitative data.

The deductive analyzes evidenced in question Q54 are based on data for the questioning Q69, since they deal with situations related to understanding the importance of structuring and implementing projects/services in order to contribute to improvement practices.

The results show that the participants were able to understand the guidelines related to maintaining responsibility, participation and commitment to structuring and fulfilling the necessary activities in the context of SPI, as they did not fail to deliver the demands, acting consciously to fulfill what was established in the activity backlog. Therefore, the application and the expected result of the 'Tutoria' element are evidenced

in the guidelines, understanding of the responsibilities and performance of those involved in the approach.

6.19 Analysis of the problem 'Lack of consistent planning by the top management of the organization'

For the problem Lack of *Consistent Planning by the Top Management of the Organization*, 2 (two) questions were elaborated to be answered, and 4 (four) of 7 (seven) evaluation criteria defined in the context of the dynamics were used in the analysis.

For the '**Build from scratch**' element, a questioning (*Q70 - Did the gamified approach promote the provision of suggestions by top management to employees regarding the necessary measures in the context of the model to be implemented?*) to analyze the **Performance (C01)** and **Participation (C05)** criteria, considering the quantitative data to obtain the result. Thus, the following deductive analysis on criteria C01 and C05 was obtained:

- During the development of the missions, the participants were able to point out possible changes to improve the procedures adopted throughout the dynamics, the Senior Management Representative also provided suggestions, however, he acted more in directing the discussions regarding the suggestions provided by those involved, acting as a moderator of the suggestions: in Mission 1 all the participants provided suggestions, therefore, they scored in the mission, in Mission 2 only the participant H02 did not score, as he did not provide a suggestion, in Mission 3 there were no suggestions, as it is a mission focused on team training with guidance from the Senior Management representative who has more than 20 years of experience in software process improvement, providing training and consulting, and in Mission 4 there were few suggestions, which can be justified by a more practical and interactive round in its development.

The results of this element show that the participants were able to work collaboratively with suggestions to improve the procedures adopted throughout the dynamic, the senior management representative also provided suggestions, however he acted more in directing the discussions regarding the suggestions provided. Participation in the structuring process evidences the application and expected result of the 'Build from scratch' element of involving them in the development stage to clarify the benefits and increase ownership in the process, and provide an environment of contribution and not obligations, in order to facilitate the implementation of the improvement.

In the application of the '**Tutoria**' element, only 1 (one) question was analyzed (*Q71 - Did employees and senior management representatives understand the importance and need to plan necessary and consistent measures considering the context of improvements in the implementation of SPI?*). In this questioning, we sought to analyze the criteria of **Awareness (C03)** and **Understanding (C06)** considering quantitative and qualitative data in the analysis. Thus, the following deductive analysis on criteria C03 and C06 was obtained:

- It was observed that the senior management representative was present, participating and accompanying the team in missions 1, 2, 3. This demonstrates the understanding of the importance of their participation and commitment in the approach with the team, being noticeable that their presence generated a commitment greater of the participant in the demands. The other participants developed the necessary activities in missions 2 and 4 to achieve the improvement results, which demonstrates the understanding of the guidelines related to the improvement context, as well as the understanding of the importance of commitment and fulfillment of the necessary demands to be performed.

The results show that the senior management representative was present, participating and accompanying the team, this demonstrates the understanding of the importance of his participation and commitment to the approach with the team, being noticeable that his presence generated a greater commitment to the participants in the accomplishment of the demands. Therefore, the application and the expected result of the 'Tutoria' element are evidenced in the guidelines, understanding of needs and in the performance obtained by those involved in the approach.

6.20 Analysis of the problem 'Lack of model flexibility'

For the problem *Lack of Model Flexibility*, only 1 (one) question (*Q72 - Did the dynamics used in the approach provide the necessary information to employees to understand the practices present in the improvement model?*) was analyzed, considering the evaluation criteria of **Awareness (C03)** and **Understanding (C06)** for application of the 'Narrative' element in qualitative data. Thus, the following deductive analysis on criteria C03 and C06 was obtained:

The deductive analysis evidenced in the question Q66 is based as data for the questioning Q72, since they investigate whether the strategies proposed in the gamified dynamics allow the understanding and importance of implementing the necessary activities to achieve the expected results in the improvement desired process.

The results of this element show that the participants developed the necessary activities to achieve the expected results in the desired process improvement. The realization of the improvement demands demonstrates that there was an understanding of the practices present in the improvement model, which were necessary to implement the improvement. The participants' awareness was a consequence of the guidelines, clarifications and moments of incentives provided in the scenario of the SPI dynamics, which shows the application and expected result of the 'Narrative' element.

7 Discussion

The results obtained in Section 6, in which there was a detailed analysis of the application of the element to the problem, contributed to justify whether the element or group of elements that was used minimized or treated the SPI problem to which it was related.

Thus, the evidence collected from the gamified strategies applied to the problem of 'Resistance to cultural change' demonstrate that the participants were able to develop what was necessary to achieve the results, always engaged and participatory in the development of demands, with no resistance from the collaborators. in relation to the improvements required in the desired model for the context of the organization, which proves the understanding regarding the importance and benefits that the implementation of the model brings to the organizational routine.

The evidence collected from the gamified strategies applied to the problem of 'Lack of Knowledge in Software Engineering' demonstrate that the participants understood and applied the knowledge acquired in the moments dedicated to training, guidance and assistance, as they efficiently developed what was necessary for the achievement of improvement results.

As for the evidence collected from the application of gamified strategies to the problem of 'Lack of understanding of the stakeholder responsibilities', it proves that the participants were able to understand and perform the responsibilities that each one had to perform in relation to the necessary demands to achieve the results expected by the model.

For the problem 'Lack of a Support Tool', the evidence collected, from the gamified strategies applied, demonstrate that the participants contributed to the definition of tools to support the execution of the activities, as well as they understood the use of the tools, applying the knowledge obtained in the training, because efficiently developed what was needed to achieve the improvement results.

We can observe that in the application of gamified strategies to the problem of 'Lack of / little commitment from the Top Management', the top management representative was involved in the actions with the team, which contributed to the engagement and performance of the participants, as it made the stakeholders realized the importance of implementing what is expected by the improvement model.

As for the evidence collected from the gamified strategies applied to the problem of 'Little support from employees', it shows that the participants understood the importance of implementing the improvement and were aware of the responsibility that each one had to assume in the dynamics to develop what was established to achieve the SPI results.

In the problem of 'Employee turnover', we can observe that the application of gamified strategies contributed to the engagement and support of the participants, as it made those involved remain motivated throughout the implementation to perform what was expected by the improvement model.

In the problem of 'Lack of / little qualified human resources', the evidence collected from the gamified strategies applied demonstrate that the participants understood and applied the knowledge acquired in the moments dedicated to training, guidance and assistance, as they efficiently performed what was necessary to achieve it improvement results.

Regarding the problem 'Focus on certification instead of focusing on improvement', it was noticeable that in the application of gamified strategies, participants were able to

understand the importance and benefits that improvement provides to the work environment, as they collaborated by sharing suggestions and discussing solutions to help team to achieve the results provided by the model.

The application of gamified strategies to the problem of 'Lack of Governmental Incentive' was noticeable that the participants were able to create dissemination strategies that made it possible to achieve the results expected by the improvement model, with the exposure of the work developed by the team, which provided interest and recognition to the external audience.

Thus, as in the previous problem, it was noticeable that the gamified strategies applied to the problem of 'Lack of Knowledge of the Importance of Models by the Market' motivated the participants to create dissemination strategies which made it possible to achieve the results expected by the model used, with the exposure and recognition of the work developed by the team to the external public, which demonstrates the importance of adopting improvement models to provide visibility and recognition in what is developed by the group.

As for the application of the gamified strategy to the problem of 'Reduction in consulting hours as a way to reduce costs', it was noticeable that it promoted the participants' understanding of the importance of implementing what the model proposes and the benefits that the improvement provides to the work environment, because they performed the activities necessary to achieve the results expected by the model.

The application of the gamified strategy to the problem of 'Lack of / few projects to validate an improvement program' provided the participants with guidance and incentive to structure and carry out the necessary demands in the context of improvement.

The gamified strategies applied to the problem of 'Bureaucracy in improvement programs' demonstrate that the participants understood and were aware of how important it is to implement the improvements, this was noticeable when they provided suggestions and contributed to the definitions of the activities that the team had to perform to achieve the result of improvement, that is, they acted in the structuring of the necessary demands, they were not submitted to work on a ready demand.

As the gamified strategies applied to the problem of 'Continuity of Team Engagement in the Defined Process' demonstrate that participants understood and were aware of how important it is to implement and maintain the results of improvement in the organizational environment, the use of feedback from activities was an incentive to further improve the work performed by each team member, making it possible to continue what has been established.

The gamified strategies applied to the problem of 'Lack of / little knowledge of the models by the collaborators' show that the participants understood the importance of implementing the model and applied the knowledge acquired in the moments of training, guidance and assistance to develop what was necessary for the achieve improvement results.

The gamified strategies applied to the problem of 'Different interpretations in relation to the models' provided the participants with an understanding of the model that was implemented, since they were able to apply the acquired knowledge to practical moments, thus being fundamental to achieving the improvement results.

As for the problem of 'Lack of consistent Project Portfolio planning', it was noticeable in the results that the application of the gamified strategy provided the participants with guidance and incentive to structure and carry out the demands for improvement in line with the organization's objectives and needs.

The application of gamified strategies to the problem of 'Lack of consistent planning by the organization's top management' promoted the participants' understanding and incentive to plan and establish activities that meet the demands for improvements as well as their organizational needs.

The application of the gamified strategy to the problem of 'Lack of flexibility of the models' favored the understanding of the participants of the information necessary to guide the implementation of the model, as the participants contributed to structuring and developing activities that met the demands for improvements as well as their needs. organizational. Therefore, they were not submitted to work on an already established demand, with strategies that were not suitable for the organization's scenario.

The results obtained in the application of the elements to the problems help to answer the main question of the study "Did the gamified approach help to solve the problems or difficulties in the implementation of SPI", in which it is concluded that the approach developed and applied to the 20 (twenty) problems that occur in the context of SPI contributed significantly to solving the problems, as those involved were able to perform the necessary activities to obtain the desired result, motivated and aware of the importance and benefits that the implementation of SPI promotes to the organization. Therefore, the problems were assisted by the gamification dynamics, which demonstrates that the use of the approach can help in solving problems or difficulties experienced in SPI implementations.

8 Threats to validity

According to Wöhlin et al. [42] it is necessary to identify threats to the validity of a study, as such threats can impact or limit the results of the feasibility study. Thus, in the next subsections, the threats addressed in this study will be presented.

8.1 Internal validity

Threats to internal validity are procedures, treatments or experimental experiences of participants that threaten the researcher's ability to draw correct inferences from data about the population in an experiment [43].

In the study, a threat to internal validity related to maturation was identified. Its existence occurs because the researcher cannot limit the search for external knowledge to those involved in the implementation of improvement. As a way of trying to reduce this influence, support materials were made available to participants in Google Classroom, an environment that made it possible to centralize and manage materials, to assist in the understanding and development of the demands necessary for the context of improvement. As well as the availability of the researcher to answer questions and assist any member of the Laboratory team outside the meeting hours.

8.2 External validity

Threats to external validity highlight external events that can hamper the analysis and generalizations of study results [43]. Thus, the execution of the study took place only in one scenario, in the Laboratory. The scenario is composed, among other aspects, by the size, the profile of the team, the capacity of the processes and its maturity in terms of continuous improvement of its organizational processes. Therefore, the sampling has low representation, given the many possibilities of application of the approach in different scenarios of software process improvement, which configures a restriction to the generalization of the results obtained.

Therefore, it is recommended that the results be generalized to the approximate number of participants present in the study, which, according to Rouiller [41], fits into the context of a small organization, commonly represented by 2 to 25 employees.

8.3 Construct validity

The construction validity, for Travassos, Gurov and Amaral [44] considers the relationships between theory and observation, that is, if the treatment reflects the cause well and the result reflects the effect well.

The problem present in this study regarding construction validity is related to the participant not having the effectiveness in learning provided in the dynamics to have the ability to develop the necessary demands to fulfill the activities to achieve the results of the process improvement, this can occur from of the excess or inadequacy of explanation in the context of the dynamics. To address this threat, moments of guidance, assistance and collaborative development of demands among participants were provided throughout the dynamic. As for the amount and form of transfer of information, they were reviewed and structured to be clearer and more objective to minimize doubts about the understanding of the participants.

8.4 Conclusion validity

Conclusion validity should consider which aspects may impair the analysis and interpretation of the collected inputs [42]. A threat present in the study is the relationship of the participants' heterogeneity regarding the level of knowledge needed throughout the dynamics, which could compromise the validity of the study. To minimize this threat, the Laboratory was chosen, in which the participants could be undergraduate and graduate students who work in the context of Software Engineering, but in the case of the Study, only graduate students were volunteers. In addition, if there were difficulties in relation to knowledge, a set of documents, guidelines and training were carried out in order to standardize information and the application of the approach.

9 Conclusion

This work presented the results obtained from an Experience Report in the application of a proposal for a solution to SPI problems from the use of gamification elements suitable for the treatment of recurring problems or difficulties in SPI implementations, in the context of teaching and learning. The results obtained in the study were analyzed using the Evaluation Framework for Gamification in Software Engineering, which provides a standard framework for the design of evaluation studies for gamification cases.

The results of this work can be considered significant, since the expected results with the application of the elements to the problems were favorable to treat or minimize the problems experienced in the context of SPI, since those involved were able to perform the necessary activities to obtain the desired result, motivated and aware of the importance and benefits that the implementation of SPI promotes to the organization. However, due to threats to validity, the results cannot be generalized to any situation.

As future work, we intend to replicate the experience report in another small organization in order to compare the results obtained in the applications. And, later, apply and analyze the results in medium or large organizations to validate the effectiveness of the dynamics in a scenario with more participants.

10 Bibliographical references

[1] Montoni, M. (2010). Uma investigação sobre os fatores críticos de sucesso em iniciativas de melhoria de processos de software. Tese de D.Sc., Universidade Federal do Rio de Janeiro-UFRJ, Rio de janeiro, Brasil. https://doi.org/10.5753/sbqs.2011.15393

[2] Schots, N. C. L., Santos, G., Cerdeiral, C., Cabral, M., Cabral, R., Schots, M., Nunes, E., & Rocha, A. R. (2011). Lições Aprendidas em Implementações de Melhoria de Processos em Organizações com Diferentes Características. In: VII Workshop Anual do MPS, WAMPS 2011, pp. 84-93, Campinas, Brasil.

[3] Associação Brasileira das Empresas De Software – ABES. (2020). Mercado Brasileiro de Software - Panorama e Tendências. Brazil.

[4] García, I., Pacheco, C., Mendoza, E., Calvo-Manzano, J. A., Cuevas, G., & San Feliu, T. (2012). Managing The Software Process With A Software Process Improvement Tool In A Small Enterprise. Journal Of Software: Evolution and Process; 481–491. https://doi.org/10.1002/smr.504

[5] Mendes, F. F., Nascimento, H. A. D., Fernandes, P. G., Nunes, R. S., & Mota, C. C. (2010). Implantação de Melhoria de Processos em um Setor de Produção de Software de uma Universidade Federal. In: IX Simpósio Brasileiro de Qualidade de Software. Belém - PA. Anais do IX Simpósio Brasileiro de Qualidade de Software, p. 359-365. https://doi.org/10.5753/sbqs.2010.15445

[6] Mathiassen, L., Ngwenyama, O. K., & Aaen, I. (2005). Managing change in software process improvement. IEEE Software, v. 22, n. 6, p. 84-91. ISSN ISSN: 0740-7459. https://doi.org/10.1109/MS.2005.159

[7] Bayona, S., Calvo-Manzano, J. A., & Feliu, T. S. (2012). Critical Success Factors in Software Process Improvement: A Systematic Review. 12th International Conference, SPICE 2012, Palma, Spain, May 29-31. https://doi.org/10.1007/978-3-642-30439-2_1

[8] Mendes, F. F., Oliveira, J. L., Fernandes, P. G., & Souza, A. S. (2007). Análise de Riscos na Implantação de Melhorias de Processos de Software. In: ProQualiti-Qualidade na Produção de Software, v. 3, nro. 3, pp. 25-32.
[9] Merriam, S. B. (2009). Qualitative Research: a Guide to Design and Implementation. San Francisco, CA: Jossey-Bass.
[10] Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? – A Literature Review of Empirical Studies on Gamification. In proceedings of the 47th Hawaii International Conference on System Sciences, Hawaii, USA, January 6-9. https://doi.org/10.1109/HICSS.2014.377
[11] Cook, W. (2012). Five Reasons Why You Can't Ignore GAMIFICATION. MWorld, v. 11, n.3, p. 42-44, Fall2012. ISSN 15402991.
[12] Iacono, S., Vallarino, M., & Vercelli, G. V. (2020). Gamification in Corporate Training to Enhance Engagement: An Approach. International Journal of Emerging Technologies in Learning (iJET), 15(17), pp. 69–84. https://doi.org/10.3991/ijet.v15i17.14207
[13] Werbach, K. & Hunter, D. (2012). For the win: how game thinking can revolutionize your business. Philadelphia: Wharton Digital Press.
[14] Liu, Z.-Y., Shaikh, Z. A., & Gazizova, F. (2020). Using the Concept of Game-Based Learning in Education. International Journal of Emerging Technologies in Learning (iJET), 15(14), pp. 53–64. https://doi.org/10.3991/ijet.v15i14.14675
[15] Dorling, A. & Mccaffery, F. (2012).The Gamification of {SPICE}. Software Process Improvement and Capability Determination, pp. 295–301. https://doi.org/10.1007/978-3-642-30439-2_35
[16] Hebecker, R. & Regenbrecht, H. (2011). Visual surveys with purposeful games. Information Design Journal, v. 19, n.3, p. 259-271. https://doi.org/10.1075/idj.19.3.08heb
[17] Chou, Y. (2016). Actionable Gamification - Beyond Points, Badges, and Leaderboards. Octalysis Media.
[18] Burke, B. (2015). Gamificar: como a gamificação motiva as pessoas a fazerem coisas extraordinárias. Traduzido por: Sieben Gruppe. São Paulo: DVS Editora.
[19] Hamari, J. & Koivisto, J. (2015). Why do people use gamification services?. International Journal of Information Management. 35. 419–431. https://doi.org/10.1016/j.ijinfomgt.2015.04.006
[20] Deterding, S. (2012). Gamification: designing for motivation interactions. vol. 19, no. 4, pp. 14–17. https://doi.org/10.1145/2212877.2212883
[21] Palaniappan, K. & Md Noor, N. (2022). Gamification Strategy to Support Self-Directed Learning in an Online Learning Environment. International Journal of Emerging Technologies in Learning (iJET), 17(03), pp. 104–116. https://doi.org/10.3991/ijet.v17i03.27489
[22] Monteiro, R. H. B., De Almeida Souza, M. R., Oliveira, S. R. B., Dos Santos Portela, C., & De Cristo Lobato, C. E. (2021). The diversity of gamification evaluation in the software engineering education and industry: Trends, comparisons and gaps. In 2021 IEEE/ACM 43rd International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET), pages 154–164. IEEE.
[23] Moreira, R. T. (2008). Uma Abordagem para melhoria do processo de Software baseada em medição. Dissertação (Mestrado). Recife: CIN/ UFPE/Mestrado em Ciência da Computação. https://doi.org/10.5753/sbqs.2009.15502
[24] Minghui, W., Jing, Y., & Chunyan, Y. (2004). A methodology and its support environment for benchmark-based adaptable software process improvement. V. 6, pp. 5183-5188, The Hague, Netherlands.
[25] Niazi, M., Wilson, D., & Zowghi, D. (2005). A maturity model for the implementation of software process improvement: An empirical study. Journal of Systems and Software, v. 74, n. 2 SPEC ISS, pp. 155-172. https://doi.org/10.1016/j.jss.2003.10.017
[26] Pressman, R. S. (2002). Engenharia de Software. 6 ed. Rio de Janeiro: McGraw-Hill.

[27] Baddoo, N. & Hall, T. (2002). Motivators Of Software Process Improvement: An Analysis Of Practitioners' Views. The Journal Of Systems And Software, 62, Issue 2. https://doi.org/10.1016/S0164-1212(01)00125-X

[28] Habib, M., Ahmed, S., Rehmat, A., Khan, M. J., & ShamaiL, S. (n.d.). (2008). Blending Six Sigma and CMMI - An Approach to Accelerate Process Improvement in SMEs. Framework, 386-391 p. https://doi.org/10.1109/INMIC.2008.4777768

[29] Birk, A. & Pfahl, D. (2002). A Systems Perspective on Software Process Improvement. In: Proceedings of the 4th International Conference on Product Focused Software Process Improvement, v. 2559, pp. 4-18, Dec. https://doi.org/10.1007/3-540-36209-6_4

[30] Silva, J. P. S., Dall'oglio, P., Crespo, S., & Gluz, J. C. (2010). Uma Abordagem Prática para Implementação da Garantia da Qualidade de Processo e de Produto. In: Anais do VI Simpósio Brasileiro de Sistemas de Informação, Marabá, PA.

[31] Soares, E. M. & Oliveira, S. R. B. (2020a). An Analysis of Problems in the Implementation of Software Process Improvement: a Literature Review and Survey. In: 17th CONTECSI - International Conference on Information Systems and Technology Management.

[32] Soares, E. M. & Oliveira, S. R. B. (2020b). A Solution Proposal for Software Process Improvement Problems from the Use of Gamification. In: 17th CONTECSI - International Conference on Information Systems and Technology Management.

[33] Soares, E. M. & Oliveira, S. R. B. (2021a). Problem in SPI: An Analysis of Gamification Elements for a Proposed Resolution. In: 16th International Conference on Software Technologies (ICSOFT).

[34] Soares, E. M. & Oliveira, S. R. B. (2021b). Aplicação dos Elementos de Gamificação para Resolução dos Problemas de Melhoria do Processo de Software no Contexto de Ensino e Aprendizagem. In: XX Brazilian Symposium on Computer Games and Digital Entertainment (SBGames), 2021, Gramado - RS.

[35] Keller, J. M. (2000). How to integrate learner motivation planning into lesson planning: The ARCS model approach. VII Semanario, Santiago, Cuba, February.

[36] Park, R. E., Goethert, W. B., & Florac, W. A. (1996). Goal-Driven Software Measurement - A Guidebook. Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA 15213.

[37] Herranz, E., Colomo-palacios, R., & De Amescua-Seco, A. (2013). Towards a New Approach to Supporting Top Managers in SPI Organizational Change Management. In Proceedings of CENTERIS 2013 - Conference on ENTERprise Information Systems / ProjMAN 2013 - International Conference on Project MANagement, Procedia Technology, Volume 9, pp. 1-1372, Lisbon, Portugal. https://doi.org/10.1016/j.protcy.2013.12.014

[38] Herranz, E., Colomo-Palacios, R., De Amescua-Seco, A., & Yilmaz, M. (2014). Gamification as a disruptive factor in software process improvement initiatives. Journal of Universal Computer Science, 20(6), 885–906.

[39] Herranz, E., Colomo-Palacios, R., De Amescua-Seco, A., & SáncheZ-Gordón, M. L. (2016). Towards a Gamification Framework for Software Process Improvement Initiatives: Construction and Validation. Journal of Universal Computer Science, 22(12), 1509-1532.

[40] Herranz, E., Guzman, J., De Amescua-Seco, A., & Larrucea, X. (2018). Gamification for software process improvement: A practical approach. IET Software, vol. 13, pp. 112–121.

[41] Rouiller, Ana C. (2017). MOSE®: Base de Competências. https://doi.org/10.1049/iet-sen.2018.5120

[42] Wöhlin, C., Runeson, P., Höst, M., Ohlsson, M., Regnell, B., & Wesslén, A. (2000). Experimentation in Software Engineering: An Introduction. Norwell, USA, Kluwer Academic Publishers. https://doi.org/10.1007/978-1-4615-4625-2

[43] Creswell, J. W. (2010). Projeto de pesquisa: métodos qualitativo, quantitativo e misto. Tradução Magda Lopes. 3 ed. Porto Alegre: ARTMED, 296 páginas.

[44] Travassos, G. H., Gurov, D., & Amaral, E. A. G. (2002). Introdução à Engenharia de Software Experimental. Coppe/UFRJ, Rio de Janeiro, Relatório Técnico: RT-ES590/02.

11 Authors

Elziane Monteiro Soares, Doctoral student in Computer Science with emphasis in Software Engineering from Graduate Program in Computer Science (PPGCC) at Federal University of Pará (UFPA). Her research areas are: Software Process Improvement, Software Engineering, Software Quality, Informatics in Education and Gamification.

Sandro Ronaldo Bezerra Oliveira, PhD in Computer Science with emphasis in Software Engineering and did his postdoctoral internship at the Informatics Center, Federal University of Pernambuco. Currently he is professor and researcher at the Faculty of Computing (FACOMP) and Graduate Program in Computer Science (PPGCC) at Federal University of Pará (UFPA). He is the Lead Coordinator of the SPIDER research project, which has won many scientific awards and has already graduated many doctoral, master, graduate and scientific initiation students in Computer Science. He is consultant, appraiser and instructor of the MPS.BR and CMMI software and service quality models. His research areas are: Informatics in Education, Software Engineering and Software Process Improvement (email: srbo@ufpa.br).

Isaac Souza Elgrably, Doctoral student in Computer Science with emphasis in Software Engineering from Graduate Program in Computer Science (PPGCC) at Federal University of Pará (UFPA). His research areas are: Software Testing, Software Engineering, Software Quality and Informatics in Education (email: isaacelgrably@gmail.com).

Rodrigo Henrique Barbosa Monteiro, Master in Computer Science with emphasis in Software Engineering from Graduate Program in Computer Science (PPGCC) at Federal University of Pará (UFPA). His research areas are: Gamification, Software Engineering, Evaluation Framework and Informatics in Education (email: rodrigo.monteiro@icen.ufpa.com).

Article submitted 2022-03-04. Resubmitted 2022-03-28. Final acceptance 2022-03-28. Final version published as submitted by the authors.