

Application of a Gamification to Solve Problems of Software Process Improvement in the Educational Context: A Case Study

Elziane Monteiro Soares^a and Sandro Ronaldo Bezerra Oliveira^b
*Graduate Program in Computer Science, Institute of Exact and Natural Sciences,
Federal University of Pará, Belém, Pará, Brazil*

Keywords: Software Process Improvement, Gamification, Teaching and Learning, Problems and Difficulties.

Abstract: Specialized studies report that organizations face several problems and difficulties in conducting software process improvement initiatives. Among the existing factors are issues related to the attitudes of individuals, for example, resistance to change, lack of motivation, support and commitment of those involved in the initiatives. In this context, it is important that organizations adopt approaches and strategies to facilitate the implementation of Software Process Improvement (SPI) initiatives. Thus, the use of gamification in the context addressed can stimulate people's motivation and commitment to effectively join and participate in SPI initiatives. Gamification has been used to assist in the teaching-learning process, and can be applied in the educational area or in companies, to stimulate a learning and work climate through the motivation of the people involved. Thus, the objective of this work is to analyze the results obtained in a Case Study from the application of a dynamic with gamification elements in an SPI context.

1 INTRODUCTION

Although the adoption of standards and reference models for process improvement has grown in recent years, the number of organizations that adopt these models is a small portion of the total population of software organizations (Staples et al., 2007). Software Process Improvement (SPI) is seen as the fundamental approach to improving software products in software development organizations (Shih and Huang, 2010), being used to improve software quality and reliability, employee and customer satisfaction and return on investment, among other factors (Gibson et al., 2006; Travassos and Kalinowski, 2009).


Studies carried out in this context report problems and difficulties that organizations face to implement SPI based on process models and standards. (Baddoo and Hall, 2002; Niazi et al., 2005).


In this sense, it is important that organizations adopt approaches and strategies to facilitate the implementation of SPI initiatives, since the lack of adequate treatment and consequently the occurrence of problems is something that leads to the failure

experienced in the improvement initiatives. According to Cook (2012), many companies have used game strategies to motivate and engage the employee, not only in productivity and fun, which inevitably improves the work environment, but also to encourage innovation and development of their tasks.

Thus, the use of gamification elements can contribute to the definition of mechanisms to stimulate people's motivation and commitment to join and effectively participate in SPI initiatives. Gamification corresponds to the use of game mechanisms with the aim of solving practical problems or awakening the engagement of a specific audience and, above all, speeding up learning or training processes, making tedious or repetitive tasks more pleasant (Vianna et al., 2014). Thus, the objective of this work is to analyze the results obtained in a Case Study from the application of a dynamic with gamification elements in an SPI context.

For Chou (2016), the game elements are factors capable of driving the participant's behavior differently, where some strategies stimulate from

^a  <https://orcid.org/0000-0002-3408-8640>

^b  <https://orcid.org/0000-0002-8929-5145>

inspiration and training and others from obsession and manipulation. These elements are organized into the eight Core Drivers of the Octalysis Framework. Core Drives represent basic and fundamental factors in games that provide the motivation to perform a variety of activities and discussions.

In (Soares and Oliveira, 2020b), a correlation of the gamification elements proposed in the Octalysis Framework (Chou, 2016) to the SPI problems was performed, where for each problem one or more elements were identified with the justifications for applying the elements to minimize or treat SPI problems.

The SPI problems were obtained in (Soares and Oliveira, 2020a) from the research carried out from two perspectives: analyzes carried out in the literature and another from the analysis of results obtained with the application of a survey. In total, twenty problems were identified.

The literature review allowed us to identify problems and difficulties existing in the literature that occur during the implementation of SPI, in the result of this review eight recurring problems were evidenced, as follows: a) Change of culture in the organization, b) Lack of knowledge of software engineering, c) Lack of understanding of the responsibilities of those involved, d) Lack of support tools, e) Lack of / little commitment from top management, f) Little support from employees, g) Rotation of the personnel involved and h) Lack of / little qualified human resources.

In the application of the survey, it was possible to obtain information on the impact (occurrence) that the problems detected in the review caused, in the perception of the participants, according to their experience in SPI, and also contributed to the obtaining of new existing problems as reported by the respondents.

In total, twelve new recurring problems were identified, as follows: a) Lack of government incentives, b) Focus on certification instead of focusing on improvement, c) Reduction in consulting hours as a way to reduce costs, d) Lack of knowledge of the importance of models by the market, e) Different interpretations in relation to the models, f) Lack of / few projects to validate an improvement program, g) Lack of consistent project portfolio planning, h) Lack of consistent planning by the top management of the organization, i) Bureaucracy in improvement programs, j) Lack of flexibility in the models, k) Lack of / little knowledge of the models by employees, l) Continuity of team engagement in the defined process.

From the relationship of the gamification elements to the problems, isolated solutions were elaborated using the elements to deal with each specific problem (Soares and Oliveira, 2021a). The defined solutions made it possible to define a dynamic that integrates all the gamified elements, with the necessary procedures, methods and materials, in relation to the problems (Soares and Oliveira, 2021b).

Therefore, in this work, the results obtained from the application of the dynamics are analyzed, to the problems or difficulties of SPI, in a case study, in order to verify if the use of the dynamics promoted the learning, engagement and organizational development necessary to reach the results of the improvement.

In addition to this introductory section, this paper is structured as follows: Section 2 presents the research methodology, Section 3 presents the case study report, and Section 4 presents the conclusions and future works.

2 RESEARCH METHODOLOGY

The methodology chosen for this work consists of a Case Study. Yin (2015) states that the case study is the verification of a phenomenon based on experience, comprising a method of data collection and analysis, where the data used are obtained through documents, surveys, interviews, which, when analyzed, show evidence and results obtained.

The choice of the case study was based on the studies and definition of Gressler (2003), which reinforces that the case study is often used in exploratory research in new areas or to describe a process or effects of an intervention, or to explain a complex phenomenon. The study consolidated the analysis of the use of gamification elements to address improvement problems in the context of the SPIDER (Software Process Improvement: DEvelopment and Research) Laboratory in Brazil.

As for the approach, this research is characterized as qualitative, since the analyzed data are not numerical and aim to produce information instead of quantifying its results (Gerhardt and Silveira, 2009). In this type of research, the concern is to obtain information from the point of view of individuals and the interpretation of the environment in which they work, which is the research environment.

With regard to the objectives, this research is configured as exploratory and descriptive, because, according to Marconi and Lakatos (2003), the combination of exploratory and descriptive studies

aims to present, in its entirety, a certain event, so that the information gathering is carried out with flexible procedures and involves empirical and theoretical analyses.

3 CASE STUDY REPORT

In this section, the results obtained from the application of SPI dynamics in a case study in the SPIDER Laboratory are presented.

3.1 Planning

To carry out the dynamics of SPI, the Laboratory belonging to the SPIDER group, institutionalized since 2009 at the Institute of Exact and Natural Sciences of UFPA (Federal University of Pará) was selected.

The group is made up of professors / researchers from UFPA (Federal University of Pará), UFPE (Federal University of Pernambuco), UFLA (Federal University of Lavras) and UNIFAP (Federal University of Amapá), master's and doctoral students / researchers from the PPGCC (Computer Science Graduate Program) and FACOMP (Computer Science College) graduation from UFPA, who work in the Software Engineering (ES) and Education research line, where 7 collaborators from this group participated in the dynamic postgraduate training. This number of employees underpins the group as a small profile, which, according to Rouiller (2017), is commonly represented when they have 2 to 25 employees and represent enterprises that are normally, but not restricted to, in the early stages of the business, demanding urgency for its own survival.

The team acts as a source of creation and development of projects focused on software, presenting viable alternatives in relation to software tools to help the implementation of models (MPS.BR – Brazilian Software Process Improvement, CMMI – Capability Maturity Model Integration, MOSE – Model Guiding for Business Success, among others) in organizations.

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. The resolution of these problems is supported by the implementation of the Customer and Market dimension belonging to the MOSE® (Model Guiding for Business Success) 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 SPIDER Laboratory have support for resolution in the Customer and Market competence dimension (CM), since 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 (Rouiller, 2017).

In this context, the initial need to deal with the problems described above is 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 a company that is starting or already has a few years of experience in the market.

Given the above, this work aims to implement the CM competence dimension in the SPIDER Laboratory, considering the expected results in the 4 competence objectives of a small business unit. The implementation of the CM dimension aims to provide SPIDER with a range 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.

As for the period of application of the dynamics, it occurred in the interval between 06/24/2021 to 07/29/2021, on Thursdays, from 3 p.m. to 6 p.m. The meetings took place remotely by 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.

The dynamics was conducted with the voluntary participation of students / researchers who work in the SPIDER Laboratory, considered as a small business unit. Table 1 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 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.

Table 1: Description of the participants' profile.

Code	Training	Professional Activity	Time of Experience in ES
H1	Master	Technician	2 years
H2	Doctorate	Technician	4 years
H3	Master	Researcher	1 year e 6 months
H4	Doctorate	Professor	10 years
H5	Doctorate	Researcher	4 years
H6	Doctorate	Systems Analyst	4 years
H7	Master	Researcher	5 years

3.2 Execution

First, there was an analysis in the context of the SPIDER Laboratory in order to verify and delimit the scope and problems experienced in the environment. In this one, problems were observed that are addressed in the Customer and Market dimension of the MOSE improvement model for small organizations, according to the justifications exposed in Section 4.1.

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, current professional activity and time of experience in software engineering, presented in Section 4.1.

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 p.m. to 6 p.m., 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 highlight that the number of meetings were 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 1 of the dynamic took place, in which the procedures belonging to Mission 1 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: (i) the benefits and advantages of having a SPI model adopted in the organization, (ii) information related to institutional knowledge, (iii) the organization's strategic objectives in relation to the improvement model, and (iv) 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 in 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, and also opinions on 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 dynamics of SPI (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 are 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, so on 07/01/2021 Mission 5 initially took place with the presentation of the performance information obtained by the heroes in Mission 1,

collected in the Performance Worksheet, and then feedback was obtained from those involved regarding the dynamics of actions established in Mission 1, considering the ARCS Model (Attention, Relevance, Confidence, Satisfaction) by Keller (2000) 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: (i) the summarized experience data of those involved obtained in the Web Form, (ii) the learning path they will follow on the training mission, (iii) 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, in the form of 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 how to point 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 Learning Path with the guidelines of the context that would be dealt with in the training. The training was then conducted by the SPIDER Laboratory Coordinator, who has extensive experience in the topics covered in the training related to the practices of the CM dimension, processes and tools.

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 Beacon. 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 that was being met, that is, if it belonged to the 4 competence objectives, and later, together they defined 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 stage and the definition of the priorities of the activities were ways of providing points to those involved in the performance spreadsheet.

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 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 07/15/2021, 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 (Soares and Oliveira, 2021b). This mission required more time to develop because 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 deliveries of the activities present in Trello, in the remote context the gloves were made available to those involved in 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 site. Employees who experienced difficulties in any activity were able to request help during meetings held on Google Meet

via text chat (Chat), voice or video, or in the 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, as 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 (07/29/2021) was initially dedicated to the stages 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 arranged on App-Sorteos.com (it is 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 was carried SWOT analysis 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.

3.3 Evaluation

In the applied dynamics, there were two moments directed to the evaluation, which happened when Missions 5 and 6 were executed. It is noteworthy that mission 5 occurs in the dynamics in a transversal way, being applicable throughout the Journey at the end of missions 1, 2, 3 and 4. Mission 6 occurs when the others have already been carried out, as it aims to evaluate the dynamics as one all.

Therefore, in Mission 5 the 'Satisfaction Report - ARCS Model' was used, with questions aimed at evaluating the dynamics by those involved, considering the motivational strategies proposed in the ARCS model (Attention, Relevance, Confidence,

Satisfaction) by Keller (2000) since these four categories represent the conditions necessary for a person to be motivated, that is, each one represents an aspect of motivation. A brief description of the categories evaluated in the context of the study is presented below:

- **Attention:** aims to verify the interest, stimulation and curiosity in the dynamics,
- **Relevance:** aims to investigate whether the dynamic used is relevant / important for the Hero,
- **Confidence:** this category aims to investigate whether the methodology applied stimulated the participants' self-confidence in relation to the positive result of its application,
- **Satisfaction:** used in order to verify the participant's subjective feeling associated with the sense of accomplishment of something, for example, completing tasks, developing and testing skills, achieving goals, among others.

It is noteworthy that the collection of opinions from those involved regarding the dynamics of established actions was carried out in a Brainstorming, where the researcher used the report as a script to guide the questions to the team.

In Mission 6 a qualitative analysis was carried in a Brainstorming on Gamification in general in a SWOT analysis (Strengths-Weakness-Opportunities-Threats). For Silva et al. (2011), this analysis is extremely important in the organization, because through this tool employees have a clear and objective view of their strengths and weaknesses in the internal and external environment of the company. In this study, the SWOT matrix was used to understand the main factors that affect the results regarding the application of dynamics.

It is noteworthy that the questions asked to those involved did not occur in a mandatory way, that is, the participants could or could not report the experiences lived in the dynamics. This release occurred during the moments dedicated to evaluation, and was perceived as a negative point, as some did not provide feedback. It is important to note that a nomenclature was assigned to those involved (H1, H2..., according to Table 2) in the dynamics, in order to guarantee the anonymity of the responses.

Thus, in the existing evaluation in Mission 5, considering the Attention category of ARCS, the participants reported that the strategies adopted aroused attention to remain motivated in learning and performing the necessary activities. In this sense, participant H4 highlighted that: *“I found the theme used in the scenario of heroes very interesting, because it is something that many know and follow,*

being something that helps to hold attention and motivation in those involved.”

As for the Relevance category of the ARCS model, the participants reported that the strategies adopted in relation to guidelines and information passed on are relevant / important for those involved and carried out the implementation of the improvements expected by the model. In this sense, participant H7 highlighted that: *“Everything that has been presented so far proved to be relevant regarding the strategies that are being adopted in the construction of the process, to achieve the expected results with the improvement of the process.”*

Regarding the Confidence category of the ARCS model, the participants reported that the strategies adopted stimulated self-confidence, because with the participation and performance of the activities, they could feel confident that they were learning and applying the acquired knowledge necessary to achieve improvement. In this sense, participant H5 highlighted that: *“I believe that the organization of the dynamics was essential to help with motivation, as it made it possible for the participants to believe that they are capable of developing the proposed activities, advancing and controlling their own success in the demands.”*

As for the Satisfaction category of the ARCS model, the participants reported that the strategies adopted in relation to the activities developed and feedback from these activities generated a satisfaction of accomplishment when completing the necessary demands, where the context of development and deliveries ends up being a driving factor of satisfaction, to influence participants to achieve their pre-defined goals when carrying out an activity. In this sense, participant H3 highlighted that: *“The strategies present in the dynamics help maintain concentration and encourage the development and deliveries necessary to implement the improvement. Therefore, I am pleased to carry out the dynamics that are being proposed, and especially to obtain feedback on the activities performed.”*

As for the results obtained in Mission 6, in the SWOT analysis based on the feedback from the participants, some aspects were highlighted:

- **Strengths:**

- The applied dynamics allowed those involved to choose the activities they wanted to develop, appropriate to their profile or knowledge, it was a very good strategy, and should be maintained,

- The moments of training and orientation were very advantageous, as it contributed to the knowledge needed to implement the model improvements and understanding of the tools that would be used,

- The narrative in which the implementation in the context of heroes was developed instilled motivation and engagement in the participants,

- The dynamics aroused a lot of interaction and teamwork, there were moments of contributions to what was developed, everyone participated a lot and this was provided due to the way in which the dynamics was structured and applied.

- **Opportunities:**

- Take advantage of the strategy initially applied in the dynamics in which there is a hero role attribution among the participants, and perform a new hero role attribution at the end of the application in order to compare if there were changes in their acting and performance in the dynamics considering the perspective of the team,

- Use evolutionary avatars in the dynamics, because as the employee develops activities and performs well, he manages to increase his avatar, which can generate more motivation and engagement in his performance in the approach,

- The presentations made initially in the dynamic had a lot of information, which prolonged the transfer of information, thinking of a strategy to minimize the presentation time and the initial transfer of information.

- **Weaknesses:**

- Extensive content can make learning tiring and end up affecting the motivation of those involved,

- The rules of the activities must be clearer so that the practical part can be carried out, therefore, it is important to establish the rules in the initial presentations of the missions that will be developed.

- **Threats:**

- The organizational context where the dynamics are applied can be a threat, as there may be organizational scenarios in which there is not the same commitment to implement the improvement, that is, there may be resistance from people,

- Freedom to choose and develop tasks can be a threat, as not all employees have the same motivation and commitment to participate and develop activities.

3.4 Discussion

In the results obtained in the evaluation, it was possible to verify that the strategies of use of the gamified elements present in the dynamics of SPI instigated the interest of those involved in effectively participating in the implementation of improvement. This was noticeable in the feedback from the participants who highlighted the motivation and engagement provided by the established strategies,

resulting in the acquired knowledge, which enabled greater productivity and interaction between them.

In general, it was found that gamification transformed the work environment, generating greater engagement, quality and efficiency. In addition, it brought a lighter environment, making learning and activities more dynamic and attractive. However, it was also pointed out the need for adjustments and improvements in some strategies to improve the participants' perception and performance, which contribute to achieving the expected results in the context of SPI.

Therefore, it is concluded that gamification is an effective instrument to promote the engagement necessary to achieve the intended results of the improvement, since those involved were able to perform the activities to obtain the desired result, motivated and aware of the importance and benefits that the implementation of SPI promotes to the organization.

However, the context of the application must be analyzed, so that it is in line with the environment in which it will be implemented and with the profile of people who will be the target audience. Such consonance is important for the successful application of dynamics.

4 CONCLUSION

This study presented a report on the use of dynamics with gamification elements in an SPI context related to the treatment of problems or difficulties experienced in improvement initiatives, in order to verify if the use of dynamics promotes the organizational learning, engagement and development needs to achieve the expected results. From the analysis of the results obtained from the application, it was possible to list suggestions for improvements and positive points of those involved in the case study. The collected recommendations can help in later applications of the dynamics.

A limitation of this work is related to the forms of acceptance and participation of those involved in the dynamics, since the motivation and engagement expected by the strategies can generate different feelings in each participant, some may feel more stimulated to work in the context of SPI with elements of gamification, while others may have a lower stimulus to act in their activities or even not.

As future work, we intend to replicate the case study in a small organization in order to compare the results obtained in the applications. And then apply and analyze the results in medium or large

organizations to validate the effectiveness of the dynamics in a scenario with more participants.

ACKNOWLEDGEMENTS

The authors would like to thank the Coordination for the Improvement of Higher Education Personnel (CAPES) in Brazil for the financial support for granting an institutional PhD scholarship.

REFERENCES

- Baddoo, N., Hall, T. (2002). Motivators of Software Process Improvement: an analysis of practitioners' views. *The Journal of Systems and Software*, 62, 2.
- Chou, Y. (2016). *Actionable Gamification - Beyond Points, Badges, and Leaderboards*. Octalysis Media.
- Cook, W. (2012). *Five Reasons Why You Can't Ignore GAMIFICATION*. MWorld, v. 11, n.3, p. 42-44, Fall2012. ISSN 15402991.
- Gerhardt, T., Silveira, D. (2009). *Research Methods - handout*. Rio Grande Do Sul: Universidade Federal do Rio Grande do Sul. p. 120.
- Gibson, D. L., Goldenson, D. R., Kost, K. (2006). *Performance Results of CMMI-Based Process Improvement*. CMU/SEI-2006-TR-004, Software Engineering Institute, Carnegie Mellon.
- Gressler, L. A. (2003). *Introduction to research*. São Paulo, Edições Loyola, p. 295.
- Keller, J. M. (2000). How to integrate learner motivation planning into lesson planning: The ARCS model approach. *VII Semanario*, Santiago, Cuba, February.
- Marconi, M. A., Lakatos, E. M. (2003). *Fundamentals of Scientific Methodology*. São Paulo: Atlas, p. 310.
- 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.
- Rouiller, A. C. (2017). *MOSE®: Competency Base*. Recife: Pé Livre, Brazil.
- Shih, C. C., Huang, S. J. (2010). Exploring the relationship between organizational culture and software process improvement deployment. *Information & Management*, vol. 47, pp. 271-281.
- Silva, A. A., Silva, N. S., Barbosa, V. A., Henrique, M. R., Baptista, J. A. (2011). The Use of the SWOT Matrix as a Strategic Tool - a Case Study in a Language School in São Paulo. In: *Simpósio de excelência em janeiro*, Rio de Janeiro, Brazil.
- 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*, Brazil.
- Soares, E. M., Oliveira, S. R. B. (2020b). A Solution Proposal for Software Process Improvement Problems

- from the Use of Gamification. In: *17th CONTECSI*, Brazil.
- Soares, E. M., Oliveira, S. R. B. (2021a). Problem in SPI: An Analysis of Gamification Elements for a Proposed Resolution. In: *16th ICISOFT*, Brazil.
- Soares, E. M., Oliveira, S. R. B. (2021b). Application of Gamification Elements to Solve Problems of Software Process Improvement in the Context of Teaching and Learning. In: *XX SBGames*, Brazil.
- Staples, M., Niazi, M., Jeffery, R., Abrahams, A., Byatt, P., Murphy, R. (2007). An exploratory study of why organizations do not adopt CMMI. *Journal of Systems and Software*, v. 80, n. 6, pp. 883-895.
- Travassos, G. H., Kalinowski, M. (2009). *iMPS 2009: characterization and performance variation of organizations that adopted the MPS model*. SOFTEX, Campinas, SP.
- Vianna, Y., Vianna, M., Medina, B., Tanaka, S. (2014). *Gamification, Inc.: How to reinvent companies from games?* MJV Press: Rio de Janeiro.
- Yin. R. K. (2005). *Case study: planning and methods*. 3 ed. Porto Alegre: Bookman.

