The Use of Game Elements and Scenarios for Teaching and Learning the Function Point Analysis Technique: A Experimental Study

Estêvão Damasceno Santos and Sandro Ronaldo Bezerra Oliveira
Postgraduate Program in Computer Science, Federal University of Pará, Belém, Pará, Brazil

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Abstract: Currently, the development of new technologies occurs at all times, and tied to this is the increased competition between organizations. Based on this principle, it is essential that they seek to achieve quality in the development of their applications. One of the essential tools for this is Function Point Analysis (FPA). In view of this scenario, it is indispensable that the students have contact with this technique as soon as possible. Thus, this study aims to use the games concepts and elements to stimulate support for teaching and engaging student motivation in learning this technique of software estimation, which was taught in a postgraduate course in computer science in an brazilian federal university. For that, classes were defined to teach the FPA technique that used games elements as motivation for the students. Therefore, this research resulted in an enrichment of the knowledge of these students in the practice of estimation, commonly present and recommended the use in software quality models. This work aims to contribute to the teaching of the FPA technique for students, aiming at a better preparation for the software development market. It was also verified that the use of Gamification elements and learning scenarios for the teaching of this estimation technique was efficient, since the participating students were more dedicated to the tasks and were participative in all the different types of classes.

1 INTRODUCTION

Function Point Analysis (FPA), among other estimation techniques, is an element used to improve the quality in the software products development. According to Lopes (2011), many micro and small companies have difficulties in meeting schedules, estimating effort and the necessary cost for the development of their applications, which can often cause damages to the organization. From this technique it is possible to better manage the processes involved in the development, besides generating history for the organization. According to Pressman (2011), the FPA can be used to: estimate cost or work to design, code and test the software; predict the number of errors that will be found during the tests; predict the number of components in the implemented system.

Using FPA in software projects is something that brings many benefits to the organization, taking it to a higher level, where it is possible to have a better control of the process of product design and development and means of comparison with previous applications. Freitas et al. (2015) state that this technique is used to systematically measure the functional size of software, being a method proposed by an international organization, the International Function Point Users Group (IFPUG), and is currently recommended by governments and organizations as the standard method to be used. adopted for this measurement type.

The importance of counting function points is so relevant that this technique is recommended in the MPS.BR (Brazilian Software Process Improvement) Implementation Guide (SOFTEX, 2016) and in the CMMI, since: in one practice it is indicated, because the dimension of the tasks and products occurs, namely "Size is dimension of the functionalities from the point of view of the user ... A technique widely used to measure size of software is the technique of Function Point Analysis "; in another practice are estimated the effort and the cost necessary for the execution of the tasks and products, as base in the previously done sizing; and

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another one are established the other variables that are essential for the success of the project, which are the budget and the schedule.

Figueiredo (2015) states that this methodology can be used to promote learning by recycling a content that would be typically taught in the traditional method in a classroom or distance learning class from the inclusion of interconnected games elements of that create a learning opportunity gamified in the form of a game. That is, to associate the teaching of a certain subject with something that is very present in the current generation, the games, which can be a good alternative to awaken or increase students interest, reduce difficulties, engage them, and increase interactivity from the team. Mcgonigal (2011) states that the current generation is natively digital and has an aptitude to learn by interacting.

Evaluating this scenario, this research is motivated by the importance of applying Function Point Analysis in software development projects based on the use of Gamification elements and learning scenarios. Students are expected to learn the FPA in a practical way and thereby improve their knowledge and interest in the subject so that they understand the steps taken and are able to use the FPA score when necessary. Through the application of two experiments in postgraduate classes, the main objective of the research is to present a set of elements in the Gamification and learning scenarios that serve as a model to support the teaching of FPA software estimation technique. However, these elements that have been chosen to be worked on can also be applied to other topics. This purpose is based on empirical evidence described in the literature and by experiments carried out with graduate groups in the Software Engineering area.

In addition to this introductory section, Section 2 describes some of the theoretical foundation of the work, Section 3 discusses some related works, Section 4 presents the use of game elements, Section 5 describes the learning scenarios, Section 6 presents the evaluation of use the elements and scenarios, and finally, Section 7 discusses the conclusions and limitations.

2 BACKGROUND

Gamification is a very commercial technique, "initially used in companies to make it more agile and pleasant to carry out traditional activities such as the training of people and the adoption of new technologies" (Raposo and Dantas, 2016). Deterding et al. (2011) classify Gamification as the use of game elements in a non-game context. Through this, organizations seek to achieve greater interest and participation of their customers in the company's business, in relation to the use of products and services, using elements such as scores, bonuses, awards, ranking, among other advantages that can be obtained. In the context of education this methodology has gained prominence, because through it it is possible to add to the subject that will be taught elements belonging to the games environment and dynamics.

Mcgonical (2011) states that the new generations are increasingly making intensive use of modern digital technologies from devices such as computers, smartphones and video games, as well as social interaction applications, which according to the author is where it has the greatest presence of this public. Taking into account this context, Azevedo (2012) assures that there is no way to leave technologies like digital games outside the classrooms, because these constitute the daily life of young people having a high level of consumption by them.

Ribeiro et al. (2015) affirm that the search for new pedagogical practices that associate the use of technology with motivational strategies that arouse interest in the students is great. Gonçalves (2016) argues that one of the points discussed when it comes to the relationship between school and young people today is the distance between school culture and youth culture. In view of this, the objective of applying Gamification focused on teaching, is to relate a topic that would be taught in the traditional way, with something that is part of the youth environment, living in virtual environments and games. According to Freitas et al. (2016), with the new generations entering higher education, already possessing an experience in the virtual environments of information and games, it is natural to adhere to the use of Gamification to teach this new student profile.

As mentioned earlier, this technique is implemented from the adoption of game elements and dynamics. With this in view, Mcgonical (2011) considers that there are four characteristics that determine a game: goal, rules, feedback and voluntary participation. The goal is related to the purpose for which an individual wishes to participate in the game; the rules indicate the norms and restrictions that govern and guide the person during the execution of the game; feedback is related to the game's responses, based on the player's actions; the voluntary participation is the power of choice that the individual has to participate or not of the game.

Chou (2015) proposed a framework called Octalysis that presents eight basic motivations that leads a player to interact with a game, as can be seen below.

- **Meaning:** when the player believes that he / she is doing something greater, for a greater good or that he / she has been "chosen" to do something transcendental,
- **Accomplishment:** when the player observes their progress, skill development and, eventually, overcoming challenges,
- **Empowerment:** when the player is involved in a creative process, where he / she repeatedly has to discover "things" and try different combinations,
- **Ownership:** when the player is motivated because he / she has the sense of ownership of some thing,
- **Social Influence:** when the player is motivated by social elements, which influence people, including orientation, acceptance, social responses, companionship, as well as competition and envy;
- **Scarcity:** when the player is motivated by the desire for something he / she can not have;
- **Unpredictability:** when the player is motivated by wanting to find out what will happen next. If he / she does not know what will happen, his / her brain is involved and thinks about it many times;
- **Avoidance:** when the player is motivated by the prevention of something negative that may happen.

3 RELATED WORKS

In the study by Ribeiro et al. (2015), there is the presentation of a tool that is used for the creation of gamed subjects, titled "Game in Class", whose main function is to plan and construct subjects using games techniques and elements for the teaching of materials. This tool had as a target audience teachers who had as interest to diversify the teaching of their subjects in order to offer them in an unprecedented way through Gamification.

In (Freitas et al., 2016), there is the use of Gamification in a more specific context, where the application of the technique is performed in a subject called Fundamentals of Computer Architecture. In this work, a virtual space and the game itself were used as classroom. The main purpose of this application was to conduct duels of knowledge among students, where a set of duels constituted a battle, always related to one or more topics of the subject. As a result there was more interest and motivation of those involved in the game, i.e. the students.

In the approach of Gonçalves et al. (2016), a conceptual model is presented with the objective of supporting the planning of the Gamification, which takes into account the context in which the technique should be implemented, the educational objectives, the skills that will be needed, the behaviors and the interactions that are expected. Also considered were steps and processes, which are fundamental in the Gamification process in the education context, to be carried out in the correct way.

Monteiro et al. (2015) study the possibility of teaching programming, more specifically the Ruby language, through the methodology of Gamification, associated with distance learning. The tasks that were executed in the course were divided into four phases, where the initial concepts about algorithm construction were presented, and after each phase, as in a game, the student would advance to the final mission, where everything the acquired knowledge would be used to solve the challenge. With this, it was noticed that the methodology used did in fact contribute and favored the engagement and improved the students' learning.

Falcão et al. (2014) addressed in their studies the development of a tool to support face-to-face teaching using Gamification and game design. This study proposed the development of a platform to support students, aiming at the implementation of an environment that stimulates the interest and attention of the student outside the classroom in order to encourage them to learn more. This study took into account the great demand for such support tools in educational institutions.

In this study we will use the concepts present in this methodology to perform the teaching of the estimation technique based on the Function Points Analysis, which, from the search for related works in the specialized literature, no study was found on the use of Gamification with focus in the teaching of software estimation techniques.

4 THE USE OF GAME ELEMENTS

By the use of the theoretical reference on Gamification, it was possible to define the set of game elements that were used in this research, these will be presented next.

The four characteristics that determine a game, cited by Mcgonical (2011), served as the basis for the use of the game elements and thus the Gamification was created, where the students of a graduate group were part of a gamified classroom where: the goal was to learn the technique of software estimation using Function Point Analysis; the rules were the development of the syllabus of the subject, the challenges stipulated, the actions that the participants could develop and the creation of the learning scenarios; the feedback was determined through the resolutions of the activities that were developed in the classroom, through the points obtained by the students during the experiment and from the feedback class; finally, the voluntary participation is related to the fact that the Software Quality subject is optional, so the participation of the students was voluntary.

Afterwards, the techniques were chosen to ensure the proposed game elements, coming from the Chou (2015) framework, covering the eight core drivers cited in the meaning (empowerment, social impact; avoidance; scarcity; ownership; accomplishment), and from this were inserted some of the motivations and game elements proposed by Chou. It is important to note that since there was no software development, it was not necessary to use all existing Core Drivers in Octalysis. The following is the description of which core drivers were selected as well as the game elements that were used:

- Meaning: is the core that aims to make the participants believe that they are performing something superior or were chosen to perform a certain action,
- Empowerment: it is related to the fact that the participant is involved in a creative process where he / she repeatedly discovers new things,
- Social Influence: that are the social elements that aim to motivate the participants,
- Ownership: it is the feeling that the participant has to own or control something,
- Accomplishment: is the topic responsible for driving progress and skill development by participants.

From the selection of the core drivers mentioned and through the literature review, some game elements were chosen to contribute to the construction of the gamified classroom, they are: narrative, superior meaning, points, list of challenges, step-by-step tutorial - feedback, real-time control, learning curve, monitoring, group activities, medals and ranking. Table 1 shows the relationship between the chosen Core Drivers and the selected elements.

Table 1: Relationship between *Core Drivers* and Elements.

Core Driver	Elements
Meaning	Narrative and Superior Meaning
Empowerment	*Feedback* and Real-time Control
Social Influence	Group Activities, Medals and *Ranking*
Ownership	Learning Curve and Monitoring
Accomplishment	Points, List of Challenges and Step-by-step Tutorial

In Meaning the following game elements were selected:

- **Narrative:** this element was used in order to explain the relevance of the FPA activity to the students and the importance of the participation of all in the experimente,
- **Higher Meaning:** a point related to this element was the importance of the grade for the students, since this was part of the final grade in the subject. In addition, the participants were informed that they would be contributing to the building of the gamified classroom. It is important to point out that some students took an interest in the subject even after the experiment ended and continued to deepen the subject.

For Empowerment, the elements were as follows:

- **Feedback:** one of the objectives for the use of this element was to pass on to the students the results obtained, in this way the spreadsheet was always updated after the end of each class and the highlights as questions were praised in the classroom at the time of class,
- **Real Time Control:** in order to obtain greater control of students' participation in the experiment, a monitor was present who was responsible for recording the scores achieved by each student during each class.

For Social Influence, the elements used were as follows:

- **Group Activities:** this element was one of the most praised by the students, where it was used in two different ways. First in the Dojo activity, where all students developed a counting activity of function points. Luz and Neto (2012) describe the Dojo as a dynamic and collaborative activity inspired by martial arts

that follows a discipline in a teaching environment, with the goal to make it enjoyable and fun. In other words the activity is developed in pairs, where the participants must solve a challenge by shift, which is defined by a time limit, and the other participants are in the audience. At each end of a turn, a member of the pair goes to the audience and a member of the audience forms a new pair, so in succession until the resolution of the challenge. The other form was in the Laboratory of Programming (LAB) activities, in which the students in double were challenged to solve three challenges also related to FPA,

- **Medals:** this element was used in order to highlight the students, which could be both positive and negative, because in the use of the medals was highlighted the students who lacked the most, more arrived late, those who obtained higher marks in participation or other activities developed,
- **Ranking:** element related to the scores, which determined the position of each student in the experiment, being one of the main motivating elements.

In Ownership the selected elements were as follows:

- **Learning Curve:** it is important to emphasize that the activities were developed in a progressive way, being this element more used in the list of challenges of the LAB, where each challenge the students acquired knowledge to solve the others,
- **Monitoring:** this element was used by the students when they finished their class they had access to their rankings in the experiment. This was very important to stimulate students as there was an increase in competitiveness between them.

For Accomplishment the following elements were selected:

- **Points:** it was used to quantify student progress, activities and participation in the experiment,
- **List of Challenges:** the activities developed, such as those of the LAB, for example, had progressive practices, where each level of difficulty was increased,
- **Step-by-Step Tutorial:** in order to present the practical score of function points for the students, the Dojo activity was performed, where they jointly solved the proposed activity, and in the course of it the doubts were taken and the correction was performed.

5 THE LEARNING SCENARIOS

The learning scenarios represent the teaching environments developed by the teachers, aiming at a better way to teach a certain topic to their students (Elgrably, 2018). The purpose of these scenarios is to stimulate critical thinking and provide better teaching for students. In relation to FPA teaching, it is a technique that involves many processes and requires the student to think and have a lot of attention to carry out their analysis. Taking this into account, we saw the need to use different types of class for a better absorption of content by students. All this in order to contribute to the students' learning process and increase understanding about the Research Question.

The adoption of the learning scenarios was one of the approaches used to carry out the experiments in two graduate classes. The main objective was to extract quantitative and qualitative data to analyze if the Gamification supports the teaching of FPA, engaging, motivating and stimulating the learning of the students, and thus to stipulate which factors of Gamification stimulate more the competition, favor the learning and contribute to the evolution of the students in the FPA study.

The main game element is the competition between the students, in which the knowledge about the subject of FPA was ascertained. A spreadsheet was compiled to compute the points that the students obtained in each of the classes. In order for the participants to perform better, pre-lesson preparation was recommended, especially in the face of the LAB and Dojo challenges.

Given the beginning of each class, the students already knew the previous result and its due position in the ranking of the Gamification. As the activities were completed successfully, a certain score was generated for them. The main focus of the game was to accumulate as many points as possible so that at the end of the experiment the points numbers achieved were converted into a grade. In Table 2 it is possible to identify the game elements that were used in each class and the ways that students could achieve those scores.

Table 2: Relationship between the Learning Scenarios and the Gamification Elements and Points.

Learning Scenario	Gamification Elements	Points
Theoretical Class	Points, *Ranking*, Narrative, Superior Meaning and Real-time Control	Presence, Participations, Initiatives and Suggestions
Dojo Class	Points, *Ranking*, List of Challenges, Learning Curve, Step-by-Step Tutorial, Group Activity, Feedback, Monitoring and Real-Time Control	Presence, Participations, Initiatives and Suggestions, Participation in the Dojo
LAB Class	Points, Ranking, List of Challenges, Learning Curve, Monitoring and Real-Time Control	Presence, Participations, Initiatives and Suggestions, Participation in LAB, Conclusion of LAB and Mini Game (LAB)
Evaluation Activity (Test)	Points, Ranking, List of Challenges and Monitoring	Grade of Test and Presence
Feedback Class	Points and Ranking, Feedback, Monitoring and Real-Time Control	Presence and Participation in the Feedback Class

Among the differences in the application of the two experiments is the addition of one more theoretical class day, so that in the first class the narrative was always made about the importance of the students in the experiment, and so they were instructed on how the classroom would work and the importance of their participation throughout the experiment, as well as information on scores, bonuses and penalties. It was also emphasized the relevance of the presence of these students and their effective participation, since faults and delays were also criteria for the loss of points and the participations would generate important scores for them.

In the theoretical classes, the most relevant topics on the FPA technique were presented. In these classes the means to reach the scores basically was to have a more active participation, making suggestions, questions, generating discussions in the room, suggestions of new topics to be treated, changes and / or improvements that should be implemented.

In the Dojo-related class the focus was on the practice of counting the function points, where the challenge was to perform the analysis of the modules of login, register and change of data of an academic management system of an university.

To start the challenge in the first experiment, it was necessary to select 2 students from the class. Already in the second the students themselves took the initiative to take the initial step of the activity. Initially they formed a duo, one pilot and the other the co-pilot, and the others stayed in the audience watching and discussing what was being done by the pair and organized strategies to complete the activity. Every five minutes a member of the class replaced the co-pilot, and the student who was the co-pilot assumed the role of pilot of the pair, following that way until all of them participated and finished the activity. An important characteristic of this dynamic is that the participants in the class could not dialog with the students who were developing the activity at the moment, they only elaborated strategies for the group and assisted the next student who would participate in the activity. The monitors were divided so that one was responsible for assisting the class and checking if they were on the right track, the other was responsible for punctuating and recording on the Gamification spreadsheet the scores obtained. The fact that it was a practical activity, demanded the intense participation, the effort and the commitment of the participants.

The next practical activity was the LAB, this evaluation being the one where the students were instructed to form pairs to continue the dynamics, which was constituted of three challenges, all focused on the FPA theme. Each of these challenges had a slightly higher level of difficulty than the previous one, just as it does in general games. Below is a description of them:

- First challenge: it consisted of counting the function points of a CV system that had a very simple structure, only with external inputs and logical files,
- Second challenge: it had a slightly higher level, where besides entries and logical file, it had external queries and exits, besides the external interface file;
- Third challenge: it had the same characteristics as the previous one, but the level of complexity was much higher, where it was much more complete, having more fields and functionalities.

The last evaluative activity was an objective test, consisting of six questions, being: 3 addressing the theoretical axis of the FPA subject; and 3 involving practices similar to those worked on the dynamics of the Dojo and the LAB. All these questions have been adapted from public competition tests. This activity had the same weight as the LAB in the final mark of the Gamification, and through them it was possible to evaluate the learning acquired by the students from the methodology of applied teaching.

On the last day of class, it was time to collect students' feedback on the scenario in which they were submitted, their opinion on Gamification and how the classes were taught, whether it was possible to achieve the initially proposed goal, and also to analyze whether Functional Point Analysis has piqued a further interest that could generate continuity in the studies after the experiments. In this class the possibility of gaining points with participations, suggestions and initiatives was much greater than on other days, since in the end it was a chat, in the format of brainstorming, where some questions were asked to instigate and encourage the class to participate as actively as possible.

6 THE EVALUATION OF THE USE

As mentioned previously, two experiments were applied in graduate classes, the first counted on the presence of 15 participants, while the second counted on 11 participants. Each experiment had a feedback class, where the focus group technique was used to analyze and evaluate the suggestions, critiques and improvements on the learning scenarios that were worked on. Regarding the theoretical classes, the students stated that initially they felt a little difficulty in understanding the subject that was given, since none of them had knowledge about software estimates, much less about FPA. However, in the course of class and practice, this difficulty has been remedied. Another point cited by them was the need for another day of class, with the purpose of elaborating some exercises and debugging the theoretical axis of the subject.

The feedback related to the Dojo class was very positive, this activity was highly praised, as it was important for the good performance obtained in the LAB, in which the doubts and questions related to the practical score of the function points were taken, besides the fact the dynamics involving the whole class was very positive, because according to the students there was enough knowledge exchange between them.

LAB feedback involved both positive and negative points. The use of doubles (matching) to meet the challenges was a positive point regarding the exchange of knowledge in each pair; the proposed challenges were considered good and were within what was worked in the room. The use of FPA technique was also seen as positive in dynamics. In relation to the negative points, the main criticism was the lack of an adequate environment for carrying out the activity, such as a computer lab, for example, since there was no availability of this place, as a result, students were instructed to take their computers activities.

In general, the students considered the use of the different learning scenarios and Gamification elements to teach the topic of FPA, the dynamics of the Dojo and LAB for Gamification very good in the eyes of all, and the practical application of FPA was also highly praised, and was where everyone could realize the importance of this technique in the context of software development. Many of the points raised in these analyzes will serve as an improvement to the evolution of the research.

7 CONCLUSION

The purpose of this research was to make use of the Gamification elements and learning scenario in order to support the teaching of software estimates, with a focus on FPA.

The rationale for this teaching approach was initially to review the literature, where the purpose was to identify related works and research, and to increase knowledge about the software estimation technique of Function Point Analysis and the use of Gamification as a tool for support.

Based on the theoretical basis made, this work sought to contribute to teaching in the Software Engineering area, presenting for this the game elements and learning scenarios used in an experiment involving the teaching of FPA. Finally, this research was validated and analyzed in two experiments in the classroom, which aimed to stimulate and increase student learning, as well as to serve as a reference for future studies that wish to use this teaching process.

Due to the high comprehensiveness and relevance of this work, it can be diffused in several directions, because in addition to the obtained results, this research also had as objective to open

spaces so that other studies can use this technique applied to teaching in the computing area.

In relation to the future work, some possible improvements can be implemented in the experiment:

- Adapt the Gamification in case any student has any kind of communicative or physical deficiency, and this is not excluded from the activities;
- Implement a tool using the concepts of Gamification for the teaching of Function Point Analysis;
- Implement a way to get instant feedback from the participants, and thus stimulate the student more and more, so that he will see his performance at the time he performs the activities;
- Develop local applications to be used in activities, with the purpose of making the function point count more correct and closer to reality;

The main limitations of the experiment described in this study were: the fact that the experiment was applied at the same university where the research was carried out; the fact that only two applications of the experiment were performed; the execution of the experiment faced some limitations related to the availability of appropriate physical space, such as a computer lab.

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REFERENCES

Alves, F. P., Jaques, P., 2014. A Virtual Environment with Customized Feedback to Support Programming Disciplines. *3rd Brazilian Congress of Informatics in Education (CBIE 2014).*

Alves, L., Oliveira, S., Ribeiro, P., Machado. R., 2014. An Empirical Study on the Estimation of Size and Complexity of Software Applications with Function Points Analysis. *14th International Conference on Information Systemas & Technology Management.*

Azevedo, V. A., 2012. *Electronic Games and Education: Building a Roadmap for Your Pedagogical Analysis*.

Elgrably, I. S., 2018. *The Use of Gamification Elements for Teaching the Test Driven Development Technique*. Masters dissertation.

Falcão, A. P., Leite, M. D., Tenório, M. M., 2014. Support tool for face-to-face teaching using gamification and game design. *III Brazilian Congress of Informatics in Education (CBIE 2014).*

Figueiredo, K. S., 2015. Proposed Gamification of Disciplines in an Information Systems Course. *XI Brazilian Symposium on Information System*, Goiânia, GO.

Freitas, M., Fantinato, M., Sun, V., 2015. Improvements to the Function Point Analysis Method: A Systematic Literature Review. *IEEE Transactions on Engineering Management*, vol. 62.

Freitas, S. A. A., Lima, T., Canedo, E. D., Costa, R. L., 2016. Gamification and evaluation of student engagement in a technical discipline of undergraduate course. *XXVII Brazilian Symposium on Informatics in Education.*

Gonçalves, L. L., Giacomazzo, G. F., Rodrigeus, F., Macaia, C. B. S., 2016. Gamification in Education: a conceptual model to support planning in a pedagogical proposal. *V Brazilian Congress of Informatics in Education (CBIE 2016).*

Lopes, J. S., 2011. *Practical Guide to Function Point Analysis.*

Luz, R. B., Adolfo, N., 2012. Using Dojos de Programação for Teaching Development-Driven Testing. *XXIII Brazilian Symposium on Informatics in Education (SBIE 2012).*

Mcgonigal, J., 2011. *Reality Is Broken:Why Games Make Us Better and How They Can Change The World*. New York: The Penguin Press.

Monteiro, W. M., Oliveira, T. M., Martins, D. J. S., 2015. Gamification in Education: Possibilities for teaching programming. *Revista Tecnologias na Educação* – Ano 7 – número 13.

Pressman, R. S., 2011. *Software Engineering: A Professional Approach*.7 ed. Porto Alegre: AMG.

Raposo, E. H. S., Dantas, V. F., 2016. The Serpent Challenge - Using Gamification to motivate students in an introductory programming discipline. *XXVII Brazilian Symposium on Informatics in Education.*

Ribeiro, J. M., Figueiredo, K. S., Maciel, C., 2015. Game in Class: Creating Gamified Disciplines. *IV Brazilian Congress of Informatics in Education (CBIE 2015).*

Softex, 2016. *MPS.BR: Improvement of the Brazilian Software Process.*

Vazquez, C., Simões, G., Albert, R., 2003. *Function Point Analysis: Measuring, Estimating, and Managing Software Projects.* 1st. ed. Érica.