

# The Use of PBL (Points, Badges and Leaderboards) Components and Game Mechanics for Teaching and Learning of Knowledge Management

**A. S. Alcantara, E. A.**

**Rodrigues, S. R. B. Oliveira**  
Graduate Program in Computer  
Science (PPGCC) - Federal  
University of Pará (UFPA)  
Belém, Pará, Brazil  
{antonilsonalcantara,  
emanorodrigues}@gmail.com,  
srbo@ufpa.br

**R. V. Junior**

Faculty of Computer Science -  
Federal University of Pará  
(UFPA)  
Belém, Pará, Brazil  
rviegas@ufpa.br

**W. R. Cardoso**

Open School in High Education  
from Brazil (ESAB)  
Belém, Pará, Brazil  
wilvison@gmail.com

## ABSTRACT

This paper presents a proposal for the use of Game Mechanics and PBL components (Points, Badges and Leaderboards) as part of the planning of a Gamification for Teaching and Learning of Knowledge Management. A breakdown of the mechanics to be used throughout the Gamification is made, and the activities that make up each stage of the flow with their respective Scores are also defined. The forms of bonuses, along with the different types of Medals, with their details, that can be conquered along the dynamics, and the form of composition of the Ranking are presented. Finally, a qualitative assessment is made by means of a SWOT analysis of the proposal and the final considerations are presented shortly thereafter.

## Author Keywords

Knowledge Management; Gamification; Learning; Teaching; Education.

## ACM Classification Keywords

- **Applied computing**~Enterprise data management
- **Applied computing**~Learning management systems
- **Social and professional topics**~Software engineering education

## INTRODUCTION

The competitive value of organizations, in the current Knowledge Society, is in the intangible asset and aimed at competitiveness, which is knowledge. Seeking to become competitive an organization needs to have a balanced portfolio of intellectual capital, in addition to having a good Knowledge Management [1].

Given the relevance of knowledge in the business area, as in other areas, two aspects related to knowledge are necessary for its viability and success at any level [2]: Knowledge assets, which must be applied, fed, preserved and used as much as possible by individuals organizations; and Processes related to knowledge to create, organize, transform, transfer, group, apply and preserve knowledge

that must be intentionally managed in all areas of comprehension.

Even with knowledge gaining notice, many organizations still do not know how to manage it, given that this new concept has caused significant changes in organizational processes, with new challenges and barriers to be overcome. It is in this context that Knowledge Management emerges as a real need for organizations seeking a better performance [1].

Jurado et al. [3] propose the use of Gamification as an alternative to improve participation in knowledge management processes.

Gamification consists the use of game elements in real contexts. There are four basic characteristics that define a Game [4]: Goals, which represent the goal to be achieved within the game, besides being the motivating factor for the player's involvement; Rules, which correspond to the restrictions, norms and limitations of the user within the game; Feedback, which is the response to the player when performing some task or action in the game informing and directing the user about the goal to be achieved; and Voluntary Participation, which represents the freedom of the player to perform or not a certain action or strategy within the game, in addition to representing their initiative to play.

The games have two motives, as Chou [5] defines: Extrinsic Motivation is the motivation that is derived from an objective, purpose or reward, where the task itself is not necessarily interesting or attractive, but because of the goal or reward, people become motivated to complete the task [6]; Intrinsic Motivation, on the other hand, is simply the motivation you begin to have by accomplishing the task itself, where tasks would do even without having a reward for accomplishing it [6].

Werbach and Hunter [7] present three categories of game elements important for gamification, which are: dynamics,

mechanics and components. It has descending order of abstraction where each mechanic is related to one or more dynamics, and each component is connected to one or more elements of higher levels.

According to Werbach and Hunter [7], the Dynamics correspond to the general aspects of the gamified system that must be managed, however it can not enter directly into the game. The author lists some more important Dynamics, such as: **Restrictions**, which are existing limitations or forced compensations within the game that limits the freedom of the players; **Emotions**, which reinforce people's desire to keep playing; **Narrative**, which represents a plot with logic and that is continuous making the game coherent; **Progression**, which allows the player's growth and evolution, giving the sensation of advancement in the game; **Relationships**, represented by social relations, that allows the generation of partnerships feelings, status, altruism, among others.

The authors further state that, in turn, mechanics are the basic processes that drive action and engender players. They refer to specific elements directing players to a desired direction, delimiting their actions within the game. Each mechanic is a way to achieve one or more dynamics. The authors identify ten important game mechanics, which are: **Challenges**, which are tasks that represent the goal of the game for participants and which require effort to solve; **Chance**, an attribute that creates a sense of surprise and uncertainty; **Competition**, which generates the feeling of victory and defeat; **Cooperation**, which drives teamwork to achieve a goal common to all; **Feedback**, an attribute that enables players to see their performance and thus assess whether their actions are consistent with the purpose of the task; **Acquisition of Resources**, where the player is motivated to obtain items that help to achieve a certain goal or that are collectible; **Rewards**, which represents a benefit received by some action or achievement made in the game; **Transactions**, which are trades made between players - buy, sell or exchange - made directly or through intermediaries; **Shifts**, attribute that determines the time and opportunity for each player to make his move, guaranteeing the sequential participation of all involved; **Win states**, which represents the requirements that make a player or group the winner.

Finally, Components are more specific forms than mechanics or dynamics, and can be viewed and used in the game interface. The fifteen most important game components are: **Achievements**, which represents the reward for achieving a set of defined goals; **Avatars**, which are visual representations of a player's character; **Medals**, which are visual representations of in-game achievements; **Boss Fights**, represented by challenges of more difficult levels at the end of a stage of the game; **Collections** are the sets of items accumulated by the player throughout the game; **Combat**, which is a battle, usually of short duration, for the player to defeat the opponents; **Content Unlocking**,

an attribute that is available when players reach predetermined goals, culminating in content delivery; **To Gift**, which is evidenced by opportunities to share resources with other players; **Ranking**, which are visual displays of player progression and achievement; **Levels**, which are numerical representations of the progression of the player, which increases according to his performance in the game; **Points**, which are numerical representations of the progression of the game, usually linked to levels; **Missions**, which are predefined challenges with goals and rewards that must be performed within the framework of the game; **Social Charts**, which is a representation of the social network of players within the game; **Teams**, represented by defined groups of players working together to achieve a common goal; **Virtual Goods**, which are game assets that can be collected and used in a virtual way and that have perceived value [7].

Points can be applied in different ways, performing various functions. The author identifies six different applications of Points in gamification: as a way of accumulating punctuation; as indicative of the state of victory, if any, in a gamified process; The points allow a relationship between progression in the game and extrinsic rewards, in order to motivate the participants to reach a certain amount of points; as a feedback tool; also, progress indicator; and as an information provider for the gamification designer [7].

The medals are a visual representation of some achievement within the gamified process. Some medals represent a certain level of points while others mean different types of activities. In the context of gamification medals may represent a way for players to demonstrate certain skills [7].

The authors present five motivational characteristics of the use of the medals: they can provide a goal to be achieved; as a guide to what is possible within the gamification and generate an abbreviation of what is to be done; as indicative of the importance given by the user to their achievements; as virtual status of the player and his personal journey in gamification; and as the identity of a group.

The Ranking is a form of feedback, showing the classification of the players in relation to the others, as well as their personal evolution. It is a way of making public the performance of each participant, if it is important, in addition, in some cases, be an efficient motivator [7].

According to Costa and Marchiori [8], the biggest challenge is to put all these elements together in a gamification, and be aware that they will make your project attractive to the participants. It is also necessary to note that it is unlikely to include all these elements within any category. However, it is worth considering a large set of possible options at each step of the gamification, otherwise there will be many limitations.

Gonçalves et al. [9] affirm that the growing interest in the use of Gamification is due to its potential to influence, aggregate and stimulate users. But it is extremely important

to plan the process of Gamification in the educational context, which considers the objectives to be achieved, the contents that will be given and the strategies with the expected results.

Thus, this paper presents the Games Mechanics and the PBL (Points, Badges and Leaderboards) Components used as part of the planning of a Gamification proposed in [10], to support the Teaching and Learning of assets and the Management process of Knowledge, in addition to detailing: the Mechanics that will be used throughout the Gamification; the activities that make up each stage of the flow, with their respective Scores; the forms of bonuses and the different types of Medals that can be conquered along the dynamics; and, Ranking.

In addition to this introductory section, the second section presents some related works, the third section describes the use of mechanics and PBL components used in this research, the fourth section describes an evaluation performed for this work and the fifth section presents the conclusions and future work.

#### RELATED WORKS

Elm et al. [11] present the software CLEVER, which proposes a game of trivia (questions) and RPG for dissemination of business knowledge. This game uses games elements and each battle is won with correct answers. One of the weaknesses is that the game does not include knowledge generators, an important person in knowledge management who produces new knowledge (assets) for the organization, and also does not define the experts to validate knowledge, since all knowledge generated must be analyzed by an expert in order to determine the efficiency and usefulness of a given knowledge. One point of improvement proposed as future work is an evaluation with a large number of participants to validate this game, design a repository of knowledge to store and maintain the management of all knowledge generated and useful to the organization, and integrate the game with that repository of knowledge.

Yin et al. [12] present Light Quest, which proposes a game to increase motivation in the generation, dissemination and evaluation of knowledge. It is a game that stimulates the ability to produce, disseminate and absorb knowledge in the organizational environment, using Cards where knowledge is recorded and then evaluated and scored by another team. This score is used to increase the character level of the user who registered the knowledge. One of the weaknesses is that the evaluation of the Cards is made by people who may not be experts in that knowledge to be evaluated. One of the points of improvement is to add an expert for the reevaluation of the Knowledge Cards, and to do an experiment for a great period with many users.

In this context, Alcantara and Oliveira [10] present a Gamified proposal for Support to Teaching and Learning of Knowledge Management. Stimulating the process of

generation, dissemination, capture, absorption and socialization of knowledge along different stages of a Gamification flow, contemplating the main characters of the Knowledge Management process, such as: the knowledge generators responsible for producing new assets for the organization, and the Expert, responsible for validating the knowledge produced, since all knowledge generated needs to be analyzed by an expert in order to check the efficiency and usefulness of a given knowledge for the organization.

They also describe the Core Drives and how they are used throughout the Gamification, the resources needed for their application, the indicators to be evaluated, as well as the expected results at the end of each stage of the flow. Another point presented by the authors is the Game Mechanics and the PBL Components (Points, Badges and Leaderboards) used as part of Gamification planning, to support the Teaching and Learning of the Knowledge Management assets and process, besides detailing: Mechanics to be used throughout Gamification, the activities that make up each stage of the flow, with their respective Scores, the forms of bonuses and the different types of Medals that can be conquered along the dynamics, and the Ranking.

#### THE USE OF MECHANICS AND PBL COMPONENTS

Throughout the Gamification, proposed in [11], we will use the following mechanics: **Feedback**, represented by the activity, participation and final medals, besides the Ranking stage; **Challenges**, which are composed of activities that must be performed at each stage of the flow; **Reward**, consisting of the Points and Bonus components; **Competition**, represented by the stages of the Duel and Ranking stream, in addition to the medal component, as a way to stimulate competition among the Players; **Cooperation**, present in the activity Consult Card in the Bank of Knowledge stage, where the participants are motivated, through the activity, to consult the Cards of the other participants generating scores for both the Player that consulted and the owner of the Card; and **Acquisition of Resources**, represented by the activities of Create Knowledge Card and Comment the Commentary Card, in the Generate Knowledge Cards step.

#### Description of Points and Bonuses

Points are a way of Reward assigned to the Player by performing the main activity at each stage of the Gamification Flow, and may be limited to a certain number of points or free score, where it does not have a maximum number of points, allowing the Player to increase his Score freely within the execution time of the flow step.

The Bonus is a feature that the Player will gain by its behavior and performance in each step of the Gamification flow. There are four dimensions, totaling forty Bonuses, selected to positively bonus: Presence, Participation, Suggestion and Question.

The **Presence** has as reward ten bonuses, with a maximum bonus possibility of ten. The Player must be present on time and remain until the end of each stage of the Gamification flow to receive the reward. This dimension is considered important for a good understanding of the dynamics, participation in each stage of Gamification and to stimulate a good relationship with the participants.

**Participation** indicates that the Player is aware of the dynamics and interacting, receiving zero bonus if there is not participation or two bonuses per participation up to the maximum limit of ten bonuses at each stage of the flow. Examples of participation include: Making coherent comments; answer questions; among others.

**Suggestion**, however, shows that the Player is seeking to increase and contribute to the process of Knowledge Management. The Player will receive zero bonus if there is not participation with suggestions, or two bonuses at each suggestion up to the maximum limit of ten bonuses at each stage of the stream.

Finally, the **Question** characterizes the interest in dynamics and also in understanding the functioning of Gamification. The Player will receive zero bonus if there is not participation with questions, or two bonuses per question up to the maximum limit of ten bonuses in each step of the stream.

There is also the penalty, which is an infraction committed by the Player, which will be returned with the loss of Bonuses. There are three selected dimensions that lead to loss of Bonuses: **Absence**, **Not performing activity** and **Disrupting activity**.

The **Absence** characterizes the loss of dynamics and related activities at each stage. The Player will lose, if it is missing, ten Bonuses, in each step of the flow that has been absent or did not attend.

The dimension **Do not perform the activity**, shows the lack of interest of the Player by the dynamics of Gamification. The Player will lose ten Bonuses for each stage of the Gamification flow that does not perform at least one related activity.

Lastly, the dimension **Disrupting the activity** happens when the player interrupts the dynamic with a kidding or does not allow another participant to concentrate or perform his activities, indicating that the participant is not aware of the dynamics and also damages the performance of other players. If it happens, the Player will lose two Bonuses for each untimely action.

After the counting all the positive bonuses and penalties that the participant has suffered this feature will be transformed into Stars, at the end of each stage of Gamification, being: **one Star** if the total Bonus of the participant is in the range of eleven to twenty; **two Stars** if the participant's total Bonus is in the range of twenty-one to

thirty; and, **three Stars** if the participant's total Bonus is in the range of thirty-one to forty.

#### **Description of Medals**

The medal is a way for the participant to identify their progress and their level of knowledge and participation in each stage of the flow and at the end of the Gamification. For this we chose characters known in the universe of Games and Cinema and created a ranking based on the characteristics of each hero. The following describes each character, the characteristics identified by the authors, the relationship with Gamification participants, and the weight assigned to each of them.

Shrek, a character from DreamWorks Animation LLC, whose features are, in the view of the authors: he / she likes to be isolated; does not care about teamwork; likes his / her "comfort zone"; and, has no special abilities.

The Shrek medal, whose weight is worth one, represents the participant who does not engage in the Gamification process, does not interact to stimulate the process of generation, absorption and sharing of knowledge and shows little or no interest in the dynamics.

Ninja Turtle, characters created in the 80's, which has as characteristics, in the authors' view: Teamwork; Playful, sometimes irresponsible, and, Skillful.

The Ninja Turtle, whose assigned weight is worth two, represents the participant who is little involved in the Gamification process, interacts in a minimal way and shows interest in the dynamics.

Piccolo, a fictional character in Akira Toriyama's Dragon Ball franchise, whose characteristics are, in the view of the authors: teamwork; assumes leadership position; skillful; is responsible; and is not the strongest of the group.

The Piccolo medal, whose weight is worth three, represents the participant who engages in the Gamification process, interacts generating, absorbing and sharing knowledge and demonstrates interest in the dynamics as well as stimulates the other participants.

Yoda, fictional character of Star Wars, by George Lucas, which has characteristics, in the view of the authors: teamwork; skillful; intelligent; responsible; very strong; leader; master; and has great mastery of knowledge.

The Yoda medal, whose weight is worth four, represents the participant involved in the Gamification process, interacts generating, absorbing and sharing knowledge, demonstrates interest in the dynamics and stimulates the other participants and seeks to improve the dynamics and to exploit to the maximum each stage of the Gamification flow.

#### *Medal of Activity*

The Medal of Activity is given at each stage of the Gamification Flow, where the Player can receive, if he / she participates, a certain score referring to the predicted

activities, which is described in each stage of the Flow, in the next section, and depending on the amount of points awarded, a Medal of Activity will be awarded, with the exception of the Start Step that has only Medal of Participation and Final Medal.

The score required for each Medal of Activity is defined in the planning description for each step of the flow in the next section.

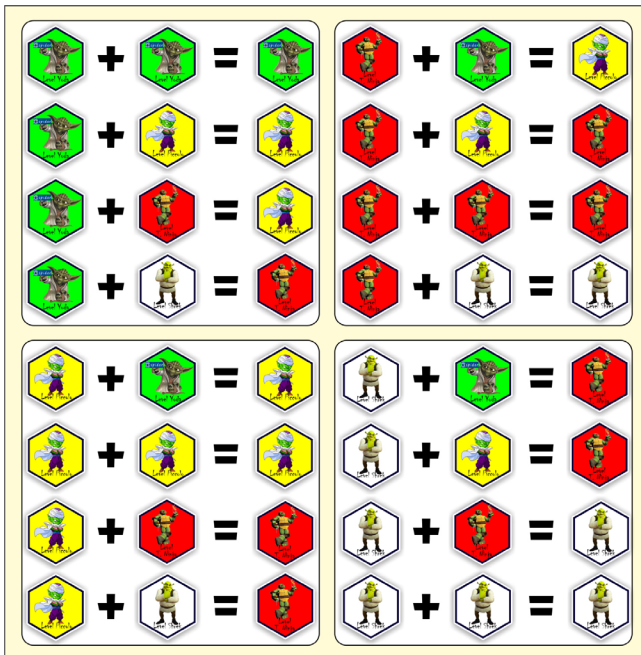
**Medal of Participation**

The Medal of Participation is given at each stage of the Gamification Flow, where the Player can receive between zero and three Stars, depending on the final amount of bonuses conquered at the end of each step, as previously presented.

According to the number of Stars won, the participant will receive the corresponding the Medal of Participation, being Shrek Medal for zero stars, Turtle Medal for one star, Piccolo Medal for two stars and Yoda Medal for three stars. This relationship is repeated in all stages of the Gamification flow.

**The Final Medal**

The Final Medal is awarded at the end of each stage of the Gamification flow, which will result from the combination of the Medal of Activity and the Medal of Participation, with the exception of the Start Stage that differs the mode of award of the Final Medal, as shown in Figure 1.



**Figure 1. Relation between Medal of Activity with Medal of Participation.**

**General Gamification Medal**

At the end of the Gamification flow, the Player will receive a General Medal, which will result from the arithmetic

mean of all the Final Medals of the seven stages of Gamification.

For the calculation of the arithmetic mean, the seven Final Medals will be considered with their respective weights that will be summed and divided by seven (number of stages of the Gamification flow). The resulting value will define the General Medal, being: Shrek Medal, to score from 0 to 1; Ninja Turtle Medal, for punctuation of 1,1 to 2; Piccolo Medal, for score of 2,1 to 3; and, Yoda Medal, to score 3,1 to 4.

**Ranking**

The Ranking will be composed of the sum of all Activity Points, won by the Player throughout the Gamification flow, and will be displayed in descending order, with the highest ranking being the player with the highest score.

**Application of Game Mechanics in Gamification**

Next, we will describe the scores and mechanics used as part of the planning of a Gamification proposed in [13], to support the Teaching and Learning of assets and the Knowledge Management process, as well as defining the activities that must be performed at each stage of the flow, along with the scores for each of them, and the Medals used to identify the progress of the participant in the different mechanics used throughout each stage of the Gamification flow.

In the **Beginning stage** we have as main activity of the stream "Participate in the Simulated Round", with a reward of ten points, if the Player participates, with the possibility of a maximum score limited to ten points. This activity is important for the participant to visualize in practice the concepts, dynamics and tasks presented in this stage of the Gamification flow.

This stage does not have an Activity Medal, because it has Limited Scoring and a single activity (Participate in the Simulated Round). The Medal of Participation will be awarded according to the rules previously described.

The Final Medal, in the Beginning stage, will be given by the relation between Activity Points and the amount of Stars won in this stage, being: Shrek Medal, if the number of Points is zero, regardless of the amount of star, or if the amount of Points is equal to ten and the number of stars is zero; Ninja Turtle Medal, if the number of Points is ten and the number of stars equal to one; Piccolo Medal, if the number of Points is ten and the number of stars equal to two; and Yoda Medal, if the number of Points is ten and the number of stars equal to three.

In the **Generate Knowledge Cards stage**, we have the main activities of the "Create Card of Knowledge" and "Comment Card of Knowledge" flow, with a reward of ten points, for each Card created (be it a new Knowledge or Comment Card), with the possibility of unlimited maximum score. Player participation in this activity is important for Generating organizational knowledge, as well as

stimulating the culture of knowledge sharing in the participant's domain area.

The Medal of Activity, in this stage, will be assigned according to the Player's performance in the activities of "Create Card of Knowledge" and "Comment Card of Knowledge" and, according to the score received in performing these activities, will be awarded the Medal of Activity, being: Shrek Medal, to score from 0 to 20; Ninja Turtle Medal, to score from 21 to 40; Piccolo Medal, to score from 41 to 60; and, Yoda Medal, to score from 61.

The Medal of Participation, in this stage, will be assigned according to the rules previously described, as well as the Final Medal that will follow the rules previously described.

In the **Evaluate Cards stage** we have as main activities of the flow "Evaluate Card of Knowledge" and "Evaluate Comment Card", with reward of ten points, for each Card evaluated (either Knowledge or Comment), with the possibility of maximum limited score the number of Cards created in the previous step. Participation of the Player in this activity is important for exercising the identification of organizational knowledge, its relevance, and applicability, as well as stimulating the process of socializing the knowledge of the area of the participant's domain or of third parties.

The Medal of Activity, in this stage, will be assigned according to the Player's performance in the activities of "Evaluate Knowledge Card" and "Evaluate Comment Card" and, according to the score received in performing these activities, will be awarded the Medal of Activity, being: Shrek Medal, to score from 0 to 20; Ninja Turtle Medal, to score from 21 to 40; Piccolo Medal, to score from 41 to 60; and, Yoda Medal, to score from 61.

The Medal of Participation, in this stage, will be assigned according to the rules previously described, as well as the Final Medal that will follow the rules described.

In the **Identify Target Audience stage** we have as main activity of the flow "Identify target audience to which the Knowledge Card will be directed", with a reward of ten points, for each identified Card and that is not of its own authorship, with the possibility of maximum punctuation limited number of Cards evaluated in the previous step. Participation of the Player in this activity is important to exercise the identification of organizational knowledge and where it will be best used within the sectors of the organization, besides stimulating the process of socialization of the knowledge of the domain area of the participant or of third parties.

The Medal of Activity, in this step, will be assigned according to the Player's performance in the activity "Identify target audience to which the Knowledge Card will be directed" and, according to the score received when performing this activity, will be assigned the Activity Medal, being: Shrek Medal, to score from 0 to 20; Ninja

Turtle Medal, to score from 21 to 40; Piccolo Medal, to score from 41 to 60; and, Yoda Medal, to score from 61.

The Medal of Participation, in this stage, will be assigned according to the rules previously described, as well as the Final Medal that will follow the rules described.

In the **Duel stage** has as main activity the "Win Duel" stream, with a reward of fifty Points, for each Duel due, with the possibility of maximum score limited to the number of Cards evaluated and identified in the previous stages. Participation of the Player in this activity is important to motivate them, through the dispute, to improve their assessments, based on pre-established criteria, as well as to stimulate the process of socializing the knowledge of the area of the participant's domain or of third parties.

The Medal of Activity, in this stage, will be assigned according to the Player's performance in the "Winning Duel" activity and, according to the score received when performing this activity will be assigned the Activity Medal, being: Shrek Medal, to score 0 to 49; Ninja Turtle Medal, for scores of 50 to 100; Piccolo Medal, for a score of 101 to 300; and, Yoda Medal, to score from 301 and 500.

The Medal of Participation, in this stage, will be assigned according to the rules previously described, as well as the Final Medal that will follow the rules described.

In the **Pack Card and Communicate Target Audience stage**, the main activity of the "Have Card Approved" flow, with a reward of twenty points, for each approved Card, with the possibility of maximum score limited to the number of Cards created by the Player in the Generate Cards step of Knowledge. Participation in this activity is important to motivate them to create new Cards, in addition to stimulating the process of socializing the knowledge of the area of the domain of the participant or third parties through the activity Communicate target audience.

The Medal of Activity, in this stage, will be assigned according to the Player's performance in the "Have Card Approved" activity and, according to the score received in performing this activity, will be awarded the Medal of Activity, being: Shrek Medal for scoring from 0 to 20; Ninja Turtle Medal, to score from 40 to 80; Piccolo Medal, to score from 100 to 140; and, Yoda Medal, to score from 160.

The Medal of Participation, in this stage, will be assigned according to the rules previously described, as well as the Final Medal that will follow the rules described.

The **Knowledge Bank stage** has the main activities of the "Consulted Card" flow, with a Point reward for each query received on your Card, and "Consult Card" (other than your own) with a Two Point reward, for each query performed, with the possibility of unlimited maximum score. Participation in this activity is important to motivate them to absorb new knowledge through consultations, as well as

to stimulate the process of socializing the knowledge of the area of the participant's domain or of third parties.

The Medal of Activity, in this stage, will be assigned according to the Player's performance in the activities "Card Consulted" and "Consult Card", according to the score received when performing these activities will be awarded the Medal of Activity, being: Shrek Medal, to score from 0 to 6; Ninja Turtle Medal, to score from 7 to 9; Piccolo Medal, for scores of 10 to 12; and, Yoda Medal, to score from 13.

The Medal of Participation, in this stage, will be assigned according to the rules previously described, as well as the Final Medal that will follow the rules described.

At the end will be the ranking of all participants of the dynamics, based on the criteria previously mentioned.

### **QUALITATIVE EVALUATION**

According to Santos et al. [14], SWOT analysis (Strengths, Weaknesses, Opportunities and Threats), used in the analysis of environments or scenarios in order to define the strategic positioning of an organization, reveals that the proposal of Mechanics and PBL components have several Strengths that are: clarity of activities, which is evidenced by the description of the tasks to be performed at each stage of the flow; motivation, which is evidenced through tasks, scores and Medals; allows the monitoring of the evolution of the participants through medals and ranking, which depend on individual performance; adds value through the knowledge created and evaluated during Gamification, which are used to value the activity performed by the participants; use of the knowledge produced during Gamification, which, if approved, is made available in the Knowledge Framework to be consulted, resulting in a new Knowledge or Comment Card; ability to aggregate people through teamwork and socialization of knowledge, generating greater proximity among participants; and provides a dynamic learning environment for teaching about the assets and the Knowledge Management process, producing a better result of the dynamics.

The proposal of the Mechanics and PBL components have as weaknesses, from the internal SWOT perspective, the points: it requires a validation in a real context, where mechanics and PBL components can be evaluated along with the motivational factors; and requires an assessment in different contexts and companies, to verify the results in different organizational cultures.

From an external perspective, we have as Opportunities: quantification of the commitment of each participant through the Medals and Ranking, which depend on the individual performance of each Player; develop the process of Knowledge Management, given the purpose of the proposal that is to motivate participants to practice Knowledge Management; and interaction between the different areas of knowledge domain.

As Threats, from an external perspective, there is a lack of participation and commitment on the part of the participants in relation to the proposed dynamics, which would make it difficult to apply the Mechanics and PBL components.

### **CONCLUSION**

The focus of the work was to present the Mechanics and PBL components used as part of the planning of a Gamification proposed by Alcantara et al. [13], for the teaching and learning of assets and the Knowledge Management process, aiming to optimize this process through creating a scenario that encourages participants.

The work was evaluated as positive, since the use of Gamification is well accepted in the educational and business environment, and has the potential to enhance the teaching and learning process of Knowledge Management. The mechanics chosen, together with the PBL components, which are part of the Gamification, help in the engagement and participation of the users and create a scenario conducive to the generation, capture, dissemination and identification of knowledge.

As future works, the authors will apply the Mechanics and PBL components, along with Gamification, in a research laboratory. It will also be applied in a class of students of a course of the masters course. Finally, it will be applied to a nationwide public company with more than 1000 employees, focused on analyzing the efficiency and effectiveness of these definitions, as well as evaluating teaching and learning in these different scenarios.

The proposal defined in this work is planned to be implemented in two contexts in 2019: in a software quality laboratory, focused on research and development of solutions to improve the software development process of Brazilian companies; and a software engineering lab discipline of an undergraduate course in computer science focused on implementing software products for clients of a Brazilian federal university.

### **REFERENCES**

1. Regina W. do A. Aires, Fernanda K.-Moreira, Patricia de S. Freire. 2017. Industry 4.0: Desafios e Tendências para a Gestão do Conhecimento. In *I SUCEG*. Santa Catarina.
2. Kimiz Dalkir. 2005. Knowledge management in theory and practice. Boston: Elsevier.
3. Jose L. Jurado, Alejandro Fernandez, César A. Collazos. 2015. Applying gamification in the context of knowledge management. In *15th International Conference on Knowledge Technologies and Data-driven Business (15th I-KNOW)*. Austria.
4. Sérgio de Freitas, Thiago Lima, Edna Canedo, Ricardo L. Costa. 2016. Gamificação e avaliação do engajamento dos estudantes em uma disciplina técnica de curso de graduação. In *XXVII Simpósio Brasileiro de Informática na Educação (SBIE 2016)*. Minas Gerais.

5. Yu-kai Chou. 2019. Actionable Gamification: Beyond Points, Badges, and Leaderboards. Octalysis Media.
6. Adair P. Falcão, Maici D. Leite, Marcos M. Tenório. 2014. Ferramenta de apoio ao ensino presencial utilizando gamificação e design de jogos. In *XXV Simpósio Brasileiro de Informática na Educação*. Mato Grosso do Sul.
7. Kevin Werbach, Dan Hunter. 2012. *For The Win: How Game Thinking Can Revolutionize Your Business*. Filadélfia, Pensilvânia: Wharton Digital Press.
8. Armanda C. S. Costa, Patricia Z. Marchiori. 2015. Gamification, game elements and strategy: a reference matrix. In *Revista de Ciência da Informação e Documentação*. Ribeirão Preto, v. 6, n. 2, p. 44-65.
9. Leila Gonçalves, Graziela Giacomazzo, Flavia Rodrigues, Bráulio Macaia. 2016. Gamificação na Educação: um modelo conceitual de apoio ao planejamento em uma proposta pedagógica. In *XXVII Simpósio Brasileiro de Informática na Educação*. Minas Gerais.
10. Antonilson S. Alcantara, Sandro R. B. Oliveira. 2018. Uma Abordagem Gamificada para Apoio ao Ensino e Aprendizagem da Gestão do Conhecimento. In *XVII Simpósio Brasileiro de Jogos e Entretenimento Digital*. Foz do Iguaçu – Paraná.
11. Dominic Elm, Gustavo F. Tondello, Dennis Kappen, Marim Ganaba, Melissa Stocco, Lennart Nacke. 2016. CLEVER: A Trivia and Strategy Game for Enterprise Knowledge Learning. In *The ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play (CHI PLAY'16)*. Texas – USA.
12. Hao Yin, Keiko Yamamoto, Itaru Kuramoto, Yoshihiro Tsujino. 2016. Light Quest: A Gamified Knowledge-sharing System to Increase Motivation to Provide Long-tail Knowledge. In *13th ACE*.
13. Antonilson S. Alcantara, Sandro R. B. Oliveira, Raimundo V. Junior, Wilvison R. Cardoso, Luis O. A. P. Rodrigues. 2018. Aplicação de Core Drives e Elementos de Jogos para o Ensino e Aprendizagem da Gestão do Conhecimento. In *XXIII Conferência Internacional sobre Informática na Educação*. Brasília – Distrito Federal.
14. Mariana de A. Santos, J. G. Grechi, Paulo H. de S. Bermejo. 2010. Impact assessment of SCRUM in software development using SWOT analysis. In *XXX ENEGEP*. São Paulo.