A gamification to support teaching-learning of knowledge management in information technology: a plan based on features of pedagogical approaches

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***Abstract*— This Research to Practice Full Paper presents that the number of alternative teaching methods that are being explored in Information Technology teaching is increasing in an attempt to address contemporary pedagogical challenges. Thus, this work aims to adapt a gamification to meet the aspects of the main pedagogical approaches, selected in a previous work, aiming to improve the gamified approach to solve problems within the scope of the Information Technology course. To this, an adaptation was made in the flow of a gamification whose main features are to stimulate 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 knowledge generators and the expert. In this way, each stage was detailed based on the following criteria: "meeting the aspects of the pedagogical approaches", where the reason for adopting this item is presented, the changes made in the stages and additions to the gamification flow, in addition to pointing out the problems and how they are addressed in this approach; "How will this stage be performed?", where the execution of the gamification is detailed, with the roles of each participant and their assignments, and the rules of each stage of the flow, and the practical actions taken to meet the aspects of the pedagogical approaches used in that stage; and, "The instruments to be used", where we describe the work products used in the dynamics and the guide for their use. At the end of these steps, the gamification execution plan was elaborated, which was submitted to the evaluation of other experts on knowledge management and gamification, from the peer review technique. Thus, this work contributes by presenting a gamified approach to the teaching and learning of knowledge management based on the adoption of different features included in pedagogical approaches.**

Keywords—teaching-learning, knowledge management, gamification, execution plan, pedagogical approaches.

I. INTRODUCTION

Education is an active social component that is constantly changing. The teaching and learning process is challenged to a transformation in order to meet the demands of the new context that is presented [1].

In the Information Technology (IT) courses, some challenges of the current teaching model are highlighted in [1, 2], among which: (P1) disconnection between theory and practice in teaching, (P2) technical, generalist and content teaching, not focused on problem solving, (P3) lack of interdisciplinarity, (P4) content, teaching methods and tools outdated, (P5) lack of training in human skills, (P6) most students prefer to process the information with activities, speeches and active participation with the content, (P7) students prefer to learn linearly and show strong preference in logically sequenced steps and (P8) most students have a preference for the visual dimension, however the teachers adapted to the verbal dimension.

Thus, it is necessary to innovate the teaching processes, with the use of new practices and methods that contribute to the teaching-learning process, aiming to stimulate the student to a more active participation [1].

Thus, the objective of this work is to present the adaptation of a gamification applied in the context of knowledge management, based on the main pedagogical approaches, as well as to describe, together with the different work products present in the gamification, the planning of the application of this dynamic, aiming to solve the problems described in [1, 2] under the Computer Science course.

In addition to this introductory section, this paper is structured as follows: Section II reports the related works, Section III details the research methodology applied, Section IV presents the gamified framework, Section V presents the framework's execution plan, Section VI details the peer review used to evaluate the proposal and, finally, in Section VII the conclusions and futre works proposed are presented.

II. RELATED WORKS

The authors in [3] present the software CLEVER, which consists a game of questions and RPG, aiming at the dissemination of knowledge. Using game elements, this game has a battle dynamics based on correct answers, so the player who answers correctly is the winner. As weaknesses we have: the fact that the game does not include knowledge generators, that is, individuals who produce new knowledge for the organization and, also, knowledge experts are not defined throughout the work to validate the knowledge generated, which need to be analyzed by an expert in order to determine their efficiency and usefulness.

Similarly, authors in [4] present the Light Quest, a game that aims to stimulate the production, dissemination and absorption of knowledge in the organizational environment. The dynamics of cards are used, where the player records the knowledge and, in the sequence, they are evaluated and scored by another team. The score received is used as a requirement to increase the character level of the user who created the knowledge. However, this game does not present an execution plan of the activities included in this gamified framework, leaving the sequencing of tasks to the users.

III. Research Methodology

This work was carried out through the following steps: (i) Description of the adaptation in the gamification flow, where each step was planned based on the aspects of the different pedagogical approaches, presenting the changes made in the steps and additions to the gamification flow, (ii) Elaboration of an execution plan, where the planning for the execution of the gamification is detailed, with the roles of each participant and their attributions, and the rules of each stage of the flow, as well as the dynamics functioning, and (iii) In the end, this work was submitted to the evaluation of an expert in knowledge management and gamification, using the peer review technique, where the proposal was evaluated and the proposed improvements were implemented. Thus, this work contributes by presenting a gamified framework, adapted to meet the demands of the main pedagogical approaches, for the teaching and learning of knowledge management in Information Technology (IT) courses.

The authors in [5] claim that there are different ways of classifying a research. Thus, the scientific method applied is the Inductive Method, as it is characterized by a particular case study with the purpose of elaborating a generalization. From the point of view of Nature, it fits into a basic research, since it involves concepts and facts already explored and aims to advance science in the Knowledge Management in Computer Sciences. From the point of view of the Problem Approach, the research framework is Qualitative, since it deals with data that undergo changes according to the context and, thus, generates dynamism, requiring an inductive analysis for better understand their meanings.

The research is also classified as Exploratory, in order to understand its origins and characteristics, generating dominance over the problem, making it possible to elaborate a possible solution. From the point of view of Technical Procedures, this research is classified as Bibliographic, since it is based on papers and articles published in national and international conferences and journals, in addition to books by reference authors in the researched area.

IV. The Gamified Framework

The gamified framework to support the teaching and learning process of the assets and the knowledge management was based on the adaptation of the gamified proposal in [6], with modifications based on the pedagogical approaches described in [7] for the application in Information Technology courses, as can be seen in Figure 1. This framework consists of Framework Planning, Knowledge Cards, Individual Follow-up Form, Self-Evaluation Form, Knowledge Canvas, Gamification Spreadsheet and a Framework Execution Plan that will be detailed in section V.

Framework Planning is the base document containing all activities related to the stages of the gamified proposal and the rules of gamification. It describes: the participating actors, the mechanics used, the existing medals, the ranking, description of support materials and the framework's execution plan.

The actors participating in this gamification are: **Master**, responsible for defining the times in each activity and when to advance to the next stage of the flow, **Judge**, who is responsible for completing the Gamification spreadsheet, recording the scores obtained by each Player along the stages in each iteration and, at the end of each stage of the flow, presents the Ranking for the participants to view their performance, **Expert**, who is the specialist in the area of knowledge being studied, his / her function is to help in the resolution of doubts, assign a score to the Cards created by the Players, suggest challenges and indicate the knowledge that will be stored in the knowledge repository and disseminated in the group and **Players**, who are the students who participate in gamification.

Fig. 1. Flow of Knowledge Management Gamification.

The dynamics present in this gamification are: **Restrictions**, which represents the limitations or forced compensations, **Emotions**, which are dynamics that arouse feelings of curiosity, competitiveness, frustration, happiness, among others, **Progression**, which represents the growth and development of the player and **Relationships**, which represents the social interactions that generate feelings of camaraderie, status, altruism, cooperation, among others.

Composing the dynamics mentioned above, each step of the Gamification flow is formed by the following mechanics: **Activities**, which are challenges that must be performed in each step of the gamification flow, **Feedback**, represented by the activity, participation and final medals and Ranking step, **Competition**, as a way of stimulating competition between Players, **Cooperation**, where the participants are motivated, through the activity, to consult the Cards of the other participants, generating scores both for the Player they consulted and for the Card owner, **Acquisition of Resources**, represented by the activities of Create Knowledge and / or Comment Card, in the Generate Knowledge Cards step, **Reward**, formed by the Points and Bonus components (Points, reward attributed to the Player for carrying out the main activity in each stage of the Gamification Flow and Bonus, which is a resource that the Player will gain for his behavior and performance at each stage of the Gamification flow).

There are four dimensions, with an unlimited number of bonuses, selected for a positive bonus: **Presence**, which characterizes the Player being present on time and remaining until the end of the time of each stage of the flow, receiving a total of 10 bonuses, **Participation**, which represents the student's involvement through coherent

comments or answers to questions asked, where each participation is scored with 2 bonuses, **Suggestion**, which represents the contribution made by the participant to improve the dynamics, being rewarded with 2 bonuses for each suggestion and **Question**, which is a form of interaction where students are rewarded for each question with 2 bonuses.

There is also the penalty, which are infractions that result in the loss of bonuses: **Absence**, characterizes the loss of dynamics and related activities, with the loss of ten bonuses; **Do not perform the activity**, which characterizes the participant's idleness, with a loss of 10 bonuses and **Disrupt the activity**, which represents the interruption of the dynamics by the student, in an untimely way, generating a loss of 2 bonuses for each interruption.

After accounting for all positive bonuses and penalties that the participant has suffered from this resource, it will automatically be transformed into a star, being: **one Star** if the participant's total bonus 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, **three Stars** if the participant's total Bonus is in the range of thirty-one to forty and **four stars** if the total bonus is greater than forty.

Another form of feedback is the medals, which 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 gamification.

The existing medals are: **Shrek Medal**, with weight 1, which represents the participant who likes to be isolated, does not care about teamwork and likes his “comfort zone”, **Ninja Turtle Medal**, with weight 2, representing the participant who works as a team, however without much responsibility, **Piccolo Medal**, with a weight of 3, representing the participant who works in a team, takes a posture of initiative and leadership, has mastery of different skills and a great sense of responsibility and, finally, the **Yoda Medal**, with a weight of 4, which represents the participant who likes to work as a team, has mastery of different skills, is responsible, takes on leadership roles and has mastery of different skills.

There are four categories of medals: Participation, Activity, Final and General. The **participation medal** is awarded based on the number of stars earned. The total of these stars will correspond to the weight of the participation medal that the participant will receive, for example, if the participant earns three stars he will receive the Piccolo medal whose weight is three.

The **activity medal** is given at each stage of the gamification flow, depending on the amount of points earned in carrying out the main activities along the stages of the dynamics. An exception is the Beginning step, which has only a participation medal and a final medal. The score required for each activity medal is defined at each step of the flow in the framework execution plan in Section V.

The next to be described is the **final medal**, which is awarded at the end of each stage of the gamification flow, which will result from the combination of the activity medal and the participation medal, see Figure 2, with the exception of the Beginning, Ranking and Self-Evaluation steps, which are not awarded medals.

At the end of each iteration of the gamification flow, the Player will receive a **general medal**, resulting from the arithmetic average of the weights of all final medals of the gamification steps that offer this feature, and the resulting value will define the general medal based on the following intervals: Shrek Medal for the range 1.1 to 2, Ninja Turtle Medal for the range 2.1 to 3, Piccolo medal for the range 3.1 to 4 and Yoda Medal for values over 4.

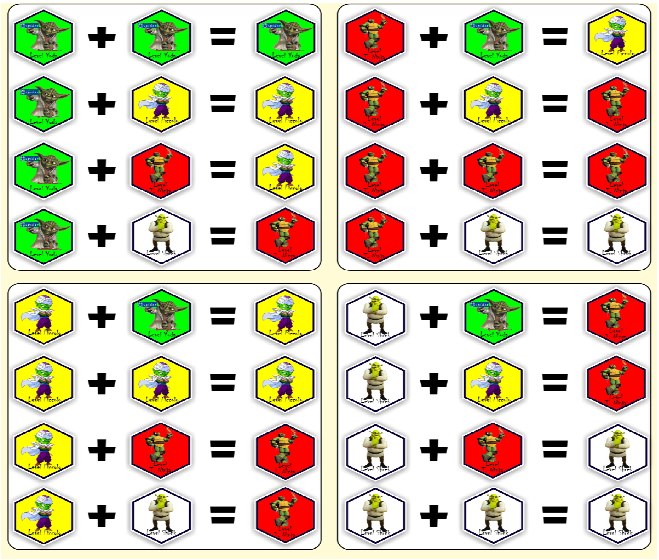

Fig. 2. Relationship between Activity Medal and Participation Medal.

The Knowledge Card is one of the main resources for the dynamics to work, see Figure 3, where the left part of the figure is the front of the card and the other part is the back. Throughout the application of gamification, participants will fill in the cards with the knowledge they deem important, based on the knowledge generating theme, which is an object of study defined by the teacher to be explored by the students.

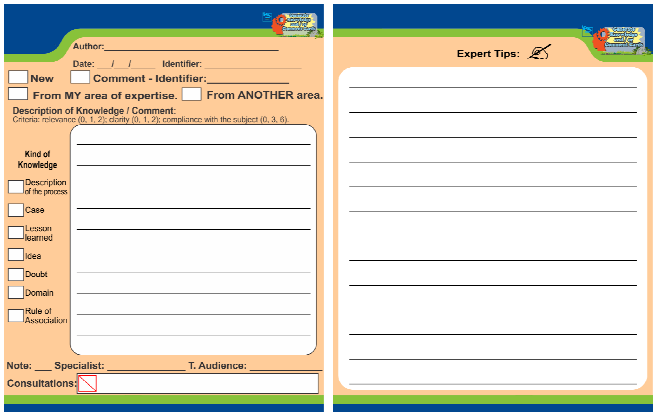

Fig. 3. Knowledge Card.

Finally, in the "experts tips" field, after evaluating a certain knowledge card, the Expert can write down one or more tips referring to this knowledge item (it can be: an idea of a new card, presenting a problem based on that item so that students can develop a solution, or even ask questions that can be answered with a new knowledge item). This tip would be accessible to all participants during the step Knowledge Factory, and also in the knowledge repository step. Thus, when evaluating the cards, the participant is also encouraged to create new items of knowledge from the tips given by the expert. This item was added in this new version

of the card to meet the demands of the cognitive pedagogical approach.

The Individual Follow-up Form, as can be seen in Figure 4, is the instrument used during the performance of the dynamics for control and monitoring by the Players regarding the execution of tasks in the Knowledge Factory step.

INDIVIDUAL FOLLOW-UP FORM

Name: _____ Occupation: _____

CREATED CARDS

Identifier	Card Type		Area	
	New	Comment	From my	From another
061	x		x	
062		X - 032		x

RATED CARDS

Identifier	Card Type		Assessment			Target Audience
	New	Comment	Relevance	Clarity	Attendance to the subject	
			( )0 ( )1 ( )2	( )0 ( )1 ( )2	( )0 ( )3 ( )6	
			( )0 ( )1 ( )2	( )0 ( )1 ( )2	( )0 ( )3 ( )6	
			( )0 ( )1 ( )2	( )0 ( )1 ( )2	( )0 ( )3 ( )6	
			( )0 ( )1 ( )2	( )0 ( )1 ( )2	( )0 ( )3 ( )6	

Fig. 4. Individual Follow-up Form.

In the step of the Evaluate Cards flow, the comments and Cards generated by other users are evaluated, and the Player cannot evaluate those that he created. Each Player, and the Expert, evaluate the Cards and Comments created in the current gamification iteration.

SELF-EVALUATION FORM

Name: _____ Occupation: _____

Phases:
1 - Beginning; **2** - Generate Knowledge and/or Comment Cards; **3** - Evaluate Cards; **4** - Identify the Target Audience; **5** - Duel; **6** - Pack Card and Communicate Target Audience; **7** - Knowledge Repository; **8** - Ranking; **9** - Self Assessment;

Nº of Iteration	Stage	Note	Goal Achieved	Iteration evaluative report	Goal
	2		( ) yes ( ) no ( ) NA		
	3		( ) yes ( ) no ( ) NA		
	4		( ) yes ( ) no ( ) NA		
	5		( ) yes ( ) no ( ) NA		
	6		( ) yes ( ) no ( ) NA		
	7		( ) yes ( ) no ( ) NA		

Fig. 5. Self-Evaluation Form.

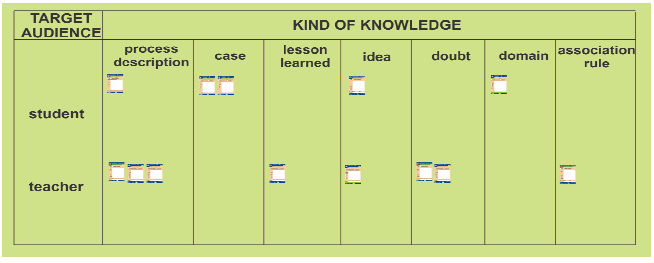

Fig. 6. Knowledge Canvas.

In the Identify Target Audience step, participants have the possibility to identify the target audience to which this evaluated knowledge item should be directed.

The Self-Evaluation Form, as can be seen in Figure 5, was adopted in this framework, meeting the demands of the Humanist and Socio-Cultural pedagogical approaches. This form allows the student to define goals and monitor their achievement, throughout the gamification flow, with the exception of the Beginning, Ranking and Self-Evaluation steps, as they are feedback steps.

The Knowledge Canvas, as can be seen in Figure 6, is where all approved cards are displayed and is organized in such a way that in the first column the target audience is presented, and in the second column the types of knowledge, being: **Process Description**, where the knowledge is exposed sequentially and logically, **Case**, where it describes a specific situation, **Lesson Learned**, which reports on learning about a particular case, **Idea**, which alludes to a suggestion for improvement or something innovative, **Doubt**, which describes a question or subject that needs an explanation, **Domain**, knowledge related to the area of expertise of those who are generating knowledge and **Association Rule**, which represents the knowledge generated from observing other facts, enabling a logical conclusion. This division aims at organizing different types of knowledge.

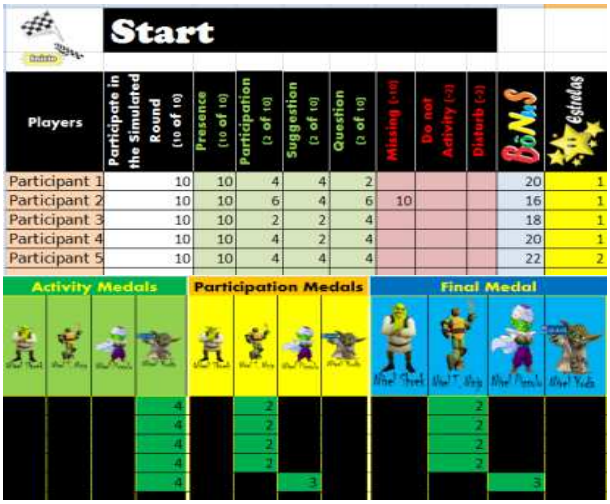

Fig. 7. Gamification Spreadsheet in the Beginning step.

V. Framework Execution Plan

This Framework was designed as a tool to support the teaching and learning of knowledge management in IT courses. Thus, it should be used as an activity of fixing, sharing and managing the knowledge learned in class, enabling the student to assess their performance.

At the end of each module studied in class, the application of this framework is suggested, with one or more iteration, to fix and socialize the acquired knowledge. At the end of each iteration, the partial result must be presented so that students can understand its evolution.

The "knowledge generating theme" can be the topic of the subject or another specific subject, and it can vary with each iteration of the framework, depending on the teacher's objective. It should also be noted that the scores are cumulative and the final result must be presented at the end of the course subject.

The framework execution plan will be described following the steps of the gamification flow. The actors participating in this gamification will perform, in all steps of the flow, the following functions: Master controlls the times and progress in each step of the flow, Judge records the scores on the gamification spreadsheet and, at the end of each step, presents the Ranking, Expert helps in solving doubts, evaluates and scores the Cards created by the Players, suggests challenges and indicates the knowledge that will be stored in the repository and disseminated in the group and Players actively participates in gamification.

The activity medal will be awarded according to the Player's performance in the activities of each step of the gamification flow, where each medal comprises different ranges of points, in the different steps, according to Table I.

TABLE I. RANGES OF ACITIVITY MEDAL POINTS AT DIFFERENT STEPS OF GAMIFICATION FLOW.

Medals	Steps of Gamification Flow			
	Knowledge Factory	Duel	Pack Card	Knowledge Repository
Yoda	Over 150	Over 400	Over 220	Over 13
Piccolo	120 to 140	300 to 350	160 to 200	10 to 12
Tartaruga Ninja	90 to 110	200 to 250	100 to 140	7 to 9
Shrek	60 to 80	100 to 150	40 to 80	4 to 6
No Medal	0 to 50	0 to 50	0 to 20	0 to 3

The **Beginning (ST)** step is the start stage of the game, aiming to give participants an overview of the dynamics by presenting the activities that will be performed, the work products that will be used, the scores that will be adopted in each activity, the general rules of the game and the rules of each step of the flow. This presentation will be guided by the Master and the Expert and is aimed at the Players, who will have the opportunity to participate in the simulation of an iteration, through the main activity "Participate in the Simulated Round" of this step, so that they better understand the dynamics. When scoring, the Judge will take note on the Gamification Spreadsheet.

In this main activity, participants will simulate an iteration of gamification going through each step of the gamification flow, presenting their details (main activities, scores, bonuses, rules), and a simulation of each of these steps and their respective main activities. For the Beginning step, the duration of 10 minutes is stipulated (which may change for more or less time depending on demand), and its main activity has a reward of ten points, with the possibility of maximum score limited to ten points. Its realization is important for the participant to visualize in practice the concepts, dynamics and tasks presented in this step.

This step does not have an activity medal, as it has a limited score and a single activity (Participate in the Simulated Round). It is also noteworthy that this step has not been changed based on pedagogical approaches, as we understand that the original planning meets the expected objectives.

Then there is the **Knowledge Factory (KF)** step, where participants have the opportunity to actively interact in the knowledge creation process. The objective of this step is to lead students to have their own experiences with regard to the process of creating knowledge items, participating in the steps of creation, evaluation and identification of the target audience. Thus, the participation of the Player in this step is important so that he can exercise the creation, evaluation and identification of organizational knowledge, in addition to stimulating the process of socialization of knowledge in the participant and third parties's domain area.

This step has an internal flow that directs participants to a set of substeps, being: Generate Knowledge and / or Comment Cards (GC), Evaluate Cards (EC) and Identify the Target Audience (IT). This step has a duration of 20 minutes, where the participants must carry out the main activities of the steps of the internal flow, and at the end of the time it is possible to advance to the next steps of flow.

Players starting in this internal flow from **GC** substep, proceeding to the **EC** substep, passing obligatorily, right after, through the **IT** substep, going to the end of the internal flow. At the end of the internal flow, there is a conditional that checks if the time allocated to the **KF** step has run out, allowing the continuation of the gamification flow. If this condition is not met, the player enters the internal flow of KF step again.

Still in this stage, KF is distributed to the players and the expert the Individual Follow-up Form and the blank Cards are made available so that they can be filled out by the players with the knowledge items.

The **GC** substep aims to direct students to create knowledge items using the blank cards, encouraging them to participate actively in the knowledge creation process. The main activities of this substep are: "Create Knowledge Card", which is the construction of a knowledge item based on the knowledge acquired from the participant and "Commenting on Knowledge Card", which is the construction of a knowledge item based on a Knowledge Card already approved by the Knowledge Repository. For both activities, a total of 10 points is assigned to each Card created or commented, therefore not having a maximum point limit, however a minimum score of 10 points is required, which will serve as a basis for the student to evaluate his performance at end of the gamification iteration.

Thus, to register a knowledge item, it is necessary to fill in some identification data on the Card, such as: Author, which is filled in with the name of the participant or the team, Date, indicating when the Card was created, Identifier, which is a sequence composed of numeric digits where the first 2 digits represent the author's registration, for a group of at most ninety-nine players, and the other digits represent the sequential number of Cards created by him, New, this field must be marked with an "X" if the knowledge to be described is a new item, or Comment, where the author marks an "X" if the knowledge to be described is related to a "Knowledge Repository" Card.

In the case of a Comment Card, it is also necessary to fill the Identifier field with the Identifier number of the Card to be commented, from MY area of expertise, a field that should be marked with an "X" if the subject to be reported is related to its area of expertise or performance; if it is not in his area of activity, the author must tick the option FROM ANOTHER area; Description of Knowledge / Comment, which is the field where the author describes a single knowledge or comment.

The Master fills in the rest of the fields, if the Card is approved, in the "Package Card and Communicate Target Audience" step, with the exception of the Consultations field, which is filled in when a Comment Card related to that Card is created. The "Grade" field corresponds to the grade attributed by the Expert, to the knowledge created based on the criteria of relevance, clarity and compliance with the subject. The Expert field must be filled in with the name of the participant with the Gamification Expert profile. The Target (Target Audience) must be filled in with the public to whom this knowledge is intended, identified by the Expert.

After the creation of the Card, each Player takes note on his Individual Tracking Card, in the "created cards" canvas,

of all his created Cards, being identified by the respective identification numbers.

The **EC** substep aims to develop the students' capacity in the evaluation process of knowledge items based on their knowledge. This step consists of the main activity "Evaluate Card", which includes the evaluation of knowledge cards and comment cards.

In this activity, the players and the expert will evaluate the cards created by the participants in the **GC** substep, and players are not allowed to evaluate the cards of their own or their team, having as criteria: Relevance, which represents the degree of importance of this knowledge, being able to be scored from zero to two, Clarity, which represents the way this knowledge is described, and can also be scored from zero to two, and Service to the Subject, which represents alignment, compliance and the potential to solve a given problem or issue, which can be scored from zero to six.

After evaluating a particular Knowledge Card, the expert can write down one or more tips regarding this knowledge item (it can be: an idea of a new card, present a problem based on that item so that students can develop a solution, or even ask questions that can be answered with a new knowledge item). This "expert tip", which is the exclusive attribution of the expert profile, is inscribed on the back of the card, and is accessible to all participants. Thus, when evaluating that Card, the player is also encouraged to create new cards from the hints.

For this subtep, a total of 10 points is attributed to each Card evaluated, therefore not having a maximum point limit, however a minimum score of 10 points is required, which will serve as a basis for the student to evaluate his performance at the end of the gamification iteration. At the end of each evaluation, it is necessary to fill out the Individual Follow-up Form, in the "Rated Cards" canvas, so that the student can monitor its development.

Finally, the **IT** substep aims to develop in the student the ability to identify the different areas of application of knowledge. This stage consists of the main activity "Identify Target Audience", which aims to identify the audience to which each item of knowledge should be directed. The players and the expert make this identification, and players are prohibited from carrying out this activity with the cards of their own or of their team. A total of 10 points is assigned to each Card that has its target audience identified, limited to the number of cards assessed in the **EC** substep, however a minimum score of 10 points (if you have assessed cards) is required, which will serve as a basis for the student can evaluate his performance at the end of the gamification iteration.

It is worth remembering that at the end of each identification, it is necessary to fill in the Individual Follow-up Form, in the "Rated Cards" canvas in the "Target Audience" column, so that the student can monitor their development.

Thus, in the **KF** step the activity medal will be awarded according to the player's performance in the main activities of the internal flow, considering the sum of the points acquired at the end of the **KF** step, where each medal comprises the following point ranges, according to Table I.

It should also be noted that this step was adjusted in order to meet the demands of the following approaches: Behavioral, which aims to increase the level of performance of students through stimuli, Humanist, through the creation of a favorable climate for the student's development, providing conditions for him to develop through his own experiences, Cognitive, through the problem-based approach to research and investigation, leading the student to work independently in the knowledge construction process, playing an active role, and Sociocultural, through problematizing education, enabling dialogue and cooperation in a constructivist process of knowledge.

The **Duel (DL)** step aims to stimulate the student through competition in order for him to dedicate himself and develop in the steps of knowledge creation. The main activity in this step is "Winning a duel", which consists of a comparison of the marks awarded by the players for a given card, with the marks given by the expert for the same knowledge item, being the winner the player who gives the card the same score given by the expert.

Thus, in this step the naster and the judge collect the individual follow-up forms from the participants and the items on the "Rated Cards" spreadsheet are compared, in order to compare the students' evaluations with the expert's evaluation and define the duel winners. For this activity, 50 points are awarded for each duel won, with the maximum score limited to the number of cards evaluated by the player in the **EC** substep, requiring a minimum score of 20 points that will serve as a basis for the student to be able to evaluate its performance at the end of the gamification iteration. It is worth mentioning that for this step a time of 5 minutes is assigned, however, this time is flexible for more or less depending on the demand of the activities to be carried out.

Still at this stage, the student can request expert feedback regarding the evaluation of a particular card, so that the student has the opportunity to understand where he needs to improve in this knowledge items evaluation process.

This step was readjusted in order to meet the characteristics of the pedagogical approaches: Humanist, with actions aimed at providing conditions for the student's development as the protagonist of this growth process, directing him to his own experience, and Cognitive, which aims to stimulate the student's intrinsic motivation, leading him to observe knowledge based on different criteria, whether assimilation or application in different contexts.

The **Pack Card and Communicate Target Audience (PC)** step aims to select the approved cards, rewarding the respective authors, and to organize them so that this knowledge is accessible to the public of interest. Thus, the cards received from the expert, in the **EC** substep, at least grade 6, based on the evaluation criteria described in the **KF** step, will be scored and exposed in the framework of knowledge (Figure 6), in the line of their respective target audience. This step is allocated a time of 10 minutes, however, this time is flexible for more or less depending on the demand for the activities to be carried out.

In this way, the master and the judge select the approved cards, filling out the gamification spreadsheet with the corresponding score, and then proceeding with the notification of the respective target audience on the existence of this new item of knowledge to be consulted in the next step.

The main activities of this step are: "Had Card Approved", with a reward of 20 Points, for each approved Card, with the possibility of a maximum score limited to the number of Cards created by the Player in the Generate Knowledge Cards step, and a defined minimum score of 20 points, and "Request Expert Feedback", giving the student the opportunity to ask the expert for the reasons that led to the refusal of their knowledge item. This activity has no score and was designed to meet the demands of the humanist approach, which suggests the provision of information.

This step was readjusted in order to meet the characteristics of the pedagogical approaches: Humanist, with actions aimed at providing conditions for the student's development as the protagonist of this growth process and Cognitive, which aims to stimulate the student's intrinsic motivation, also considering incomplete solutions, valuing the participant's effort and attempt.

The **Knowledge Repository (KR)** step aims to provide participants with socialization conditions, as a way of disseminating knowledge. Participants have the opportunity to consult the approved cards and request information from the authors about their knowledge items. This step is allocated a time of 10 minutes, however, this time is flexible for more or less depending on the demand for the activities to be carried out.

The main activities in this step are: "Consulted Card", which represents the creation and approval of a card related to consulted knowledge, with a reward of one point for each consultation received on your Card that resulted in the approval of a comment card, "Consult Card" (other than its own), with a reward of two Points, for each consultation that resulted in an approved related card, and “Explanation of the Card”, which is the detailing of its item of knowledge to the other participants when requested, with a reward of 2 points. This new activity aims to stimulate socialization and the verbal, mental and intellectual development of the student.

For all activities in this step, there is no defined maximum score, however, a minimum score to be achieved of 4 points in each iteration is defined. Thus, in the self-evaluation step the student will have an average base for analysis.

This step was readjusted in order to meet the characteristics of the pedagogical approaches: Humanist, with actions aimed at the development of the student as the protagonist of this growth process, Cognitive, which aims to provide means for the student to develop through challenges, situations in addition to encouraging cooperation, and Sociocultural, with an emphasis on relationships and social interactions as a means of socializing knowledge.

The **Ranking (RK)** step aims to present the performance of the participants throughout the gamification. It is a step of feedback and presentation of the final results of the iteration, and has no main activities, nor is it awarded medals. However, because it presents important information for self-evaluation, a time was set for students and teachers to be able to analyze and observe their performance in preparation for the next step (self-evaluation).

Thus, this step was rethought in order to meet the characteristics of the approaches: Humanist, not suppressing the information regarding its development, making it perceive itself as a unique being that develops itself, and Cognitive, through the incentive to observe, generating intrinsic motivation. The duration of the stage can occur in 5 minutes, being flexible depending on the demand for more or less time.

Finally, the **Self-Evaluation (AA)** step aims to direct the student to carry out an evaluation of his performance throughout the iteration. At this step, participants can analyze their performance along the dynamics, and fill out an evaluation form. In this form, it signals the step with the lowest performance and defines an improvement goal to be reached at the end of the next interaction.

This step was added to the gamification flow, meeting the demands of the Humanistic, Cognitive and Sociocultural pedagogical approaches, where it aims, respectively, to direct the student to perceive his performance and establish goals for his growth, highlighting the student's role as protagonist also process of evaluating their performance, and stimulating the student's reflection making him realize his difficulties and progress in the learning process.

Thus, the Self-Evaluation Form, in Figure 5, was adopted, which allows the student to define goals and monitor their achievement, throughout the gamification flow, with the exception of the Beginning, Ranking and Self-Evaluation steps, as they are feedback steps. It should also be noted that for these steps no activity medal is awarded.

After filling in the header of the form, it is necessary to indicate the number of the current iteration, in order to keep a record of the student's evolution for future analysis. Soon after, the student indicates the grade (total score) received in six of the nine steps of the flow, then indicating whether or not he reached the stipulated goal, or signaling the option does not apply (NA), if there is no goal for be evaluated in that iteration. Finally, the student can report the evaluation of his participation in this iteration, maintaining a written record of his analysis and, subsequently, he can set goals to be achieved in each step of the flow for the next iteration. The duration of this step is 10 minutes, being flexible depending on the demand for more or less time.

From the work [7], the game elements that are present throughout the steps of the gamification flow described can be listed in Table II. Thus, it is understood that the features contained in the pedagogical approaches were implemented for the execution of each of these steps of the gamification flow, which makes it possible to adapt the gamified approach to all pedagogical approaches. As shown in Table II, the game elements are distributed throughout the gamification steps.

VI. Evaluation of Execution Plan

According to [8], peer review is the process of submitting an author's academic work, research or ideas to be evaluated by other experts in the same field of knowledge. As a result, different views on the analyzed object can be obtained.

Thus, an expert PhD in Computer Science was identified, having more than ten years of teaching experience in undergraduate and graduate courses at a public federal university in Brazil, and with high knowledge about these pedagogical approaches. In addition, this expert applies the

different pedagogical approaches mentioned in the classroom and one of his lines of research is related to the use of pedagogical approaches in the teaching of educational informatics, with publications of the results in the main national and international conferences and journals.

TABLE II. RELATIONSHIP OF GAME ELEMENTS WITH THE FLOW STEPS

Game Elements	Steps of Gamification Flow								
	ST	KF			DL	PC	KR	RK	AA
		GC	EC	IT					
Superior Meaning	X	X	X	X	X	X	X	X	X
Points	X	X	X	X	X	X	X	X	X
Challenge List	X	X	X	X	X	X	X	X	X
Step by Step Tutorial	X	X	X	X			X	X	X
Boss	X	X	X	X	X	X	X	X	X
Fixed-action rewards	X	X	X	X	X	X	X	X	
Progress bar	X	X	X	X	X	X	X	X	X
Feedback	X	X	X	X					X
Voluntary autonomy	X	X	X	X		X	X	X	X
Choice perception	X	X	X	X		X	X		X
Boosters	X					X	X	X	
Virtual goods	X	X	X	X			X	X	
Duel					X				
Build from scratch	X	X	X	X			X		
Group Activity	X	X	X	X	X		X		X
Guidance	X	X	X	X	X	X	X	X	X
Monitoring									X

After identifying the expert, peer evaluation was initiated, where the planning of each step of the flow was presented and then questioned by the expert, resulting in a set of improvements. At the end of the execution of the peer review on the execution planning of the framework, thirteen problems were identified that presented themselves in different ways: from the absence of tasks to inconsistencies in the nomenclatures of steps of the flow.

The first problem found pointed to the fact that all steps were presenting the details of the execution before its purpose. Therefore, it was recommended to describe the objective of the steps before presenting the details of their executions.

The second problem identified was related to the lack of details on the tasks at each step, which made understanding difficult. Therefore, it was recommended to detail the tasks of each step, enabling an understanding of the execution of the step.

The third problem identified was the fact that the steps did not present the specification of those responsible. Thus, it was recommended to detail the participation of those responsible from the details of the steps, as well as specifying the profile of each responsible.

The fourth problem identified reports the fact that the steps do not present the work products that are used to perform the tasks. It was then recommended to present the work products from the details of the tasks, as well as describe their completion.

The fifth problem identified pointed out the fact that there is no description of the changes in the steps that have not been adjusted. As a recommendation it was pointed out that, in the steps that did not undergo adjustments, define that in these steps it remains in accordance with the original strategies of the game.

The sixth problem identified highlights that the details of the steps generating a card, evaluating a card and identifying the target audience are not composing a macro step. As a recommendation, it was suggested to detail a macro step, which incorporates the 3 substeps, then detail each substep.

The seventh problem identified pointed out that there were details of the steps that were mixed, making it difficult to understand the flow sequentially. Thus, it was suggested to include the specific details for each step.

The eighth problem identified referred to the table of scores by medal, which did not detail all the ranges of points for those medals. It was suggested, therefore, to detail the table of scores by medals, covering all the ranges of points.

The ninth identified problem pointed out that the flow did not represent the exact sequence between the steps. Thus, it was suggested to remodel the flow, presenting a macro step where it can be decomposed into three other substeps.

The tenth problem identified reported that the activities within the steps were not being described in a sequential manner, which causes confusion in the understanding of the general flow. Therefore, it was recommended to detail the activities within the steps in a sequential manner.

The eleventh identified problem pointed to the fact that the expert's feedback activity in planning was not detailed. Thus, it was suggested to detail the expert feedback in the duel step.

The twelfth identified problem was about the translation of the self-evaluation step is incorrect, implying that the evaluation represents a quality analysis. Therefore, it was suggested to change self-assessment to self-evaluation.

And finally, the thirteenth problem that reported that the self-evaluation step did not exist in the original version of the game, where the reason for its inclusion was not detailed. Therefore, it was suggested to describe the reason for the inclusion of the step as a result of meeting the pedagogical approaches.

After analyzing all the problems identified by the evaluator, it was observed that all should be considered as the basis for adjusting the gamification planning and the problems identified were solved based on the evaluator's suggestions.

VII. CONCLUSION

This work presented a gamified framework, adapted based on pedagogical approaches, and the description of an execution plan for this tool in the teaching and learning process of Knowledge Management in IT courses, with different games elements.

In addition, as future research, it is suggested: the application of this dynamic in a case study with a group of the IT course, in order to evaluate the effectiveness of the adjustments made and to carry out a comparative study between two classes of the IT course, aiming to verify the evolution of a class based on the use of the Gamified Framework, and the other without the use of gamification.

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