A GAME TO ASSIST RETAINING KNOWLEDGE IN CLASSROOM

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Abstract *— The purpose of this paper is to present an educational game developed to support consolidation and revision of contents in the classroom, using the competition, interactivity and dynamism of a team play as a learning tool more attractive to students. This paper describes the game origins and motivation, its elements and rules. In addition, the paper depicts an experimental application of this game in a Biomedicine class at a Brazilian federal university and reports the empirical study results.*

Index Terms — Game, education, knowledge consolidation.

INTRODUCTION

During a survey, 338 private and public school professors from different areas of knowledge answered, through checklists, what the barriers to their use of creative teaching practices in classroom are. According to their feedbacks, the highlighted barriers were the students' difficulties to learn (68.9% of surveyed professors) and their lack of interest in the content taught by professors in classroom (49.1%) [1].

While the classroom is seeking attractiveness, it is not hard to find what catches the students' attention outside the school environment, and the games are one of the most efficient attractions of this kind.

The use of games as Educational tools has increased due to the games popularity, easier internet access and the intrinsic characteristics of games in general which can assist the exposition of didactic content in order to make it more interesting and enjoyable for students [7].

Games are efficient teaching tools for many subjects, such as programming [6], Literacy [5], Environmental Education [4], Language [2], among others.

In this context, this paper has the purpose to present an educational game for conceptual subjects that usually require greater dedication of students. This game facilitates the understanding of the subject and complements the teaching and learning practices. In the empirical study, undergraduate Biomedicine students could develop strategically their learning about specific concepts using the game during the Hematology Fundamentals course, in which the game could assist in consolidating the content studied during a team play in class and encouraging the implementation of recreational activities to improve Biomedicine teaching practices.

This paper has the following organization: Section 2 presents the methodology applied in this study. Section 3 describes the game detailing, in the subsections, its origin and motivation, elements and rules, its prerequisites and data, architecture and implementation. Section 4 reports the application of the case study, including the implementation in classroom, evaluation and feedback. In Section 5, we present the results of applying the case study and the limitations and threats to validity of the study. Finally, Section 6 reports the conclusions and future work.

METHODOLOGY

This work is the consisted primarily of observing the execution of a group dynamic in classroom, in the traditional environment, based on paper. There were meetings with teachers and undergraduate Biomedicine research fellows to capture and validate requirements and features of the game and its contents, especially in the case of specific subjects related to Biomedicine. Among the stages, there was a period dedicated to the development and tests of the game, and for conclusion, students played the game in class and answered to a questionnaire produced to collect feedbacks with participating students.

THE GAME

The game consists of a competition between groups of students intermediated by the professor who controls the flow of the game. The students will try to guess the hidden answer to the question "Who am I?" by evaluating hints that describe it. The answer and hints refer to the subjects addressed in the course, so the students are expected to present some familiarity with the game context.

Origins and Motivation

The idea of this game originated in the use of group dynamics applied in Biomedicine classes of a federal university. With the use of a board, paper and creativity, the teacher intermediated the game, splitting the students into groups that will attempt to discover the hidden answers about concepts taught in the classroom through its characteristics. The first version of the proposed game emerged from this idea. Later there was a generalization of

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the game to other areas of knowledge, through the data supplied by the teacher, which could then work with his own database of questions, represented by answers and its hints, also named in the system as cards.

The motivation of this game is to transform the learning of contents that are difficult to assimilate in a fun and interactive way of learning in order to attract students' attention and motivate them to recall the contents read at home or seen in classroom. While they exercise this recall, they can get the right answer and earn points to win the competition performed through the game.

The game stimulates identification and consolidation of important concepts in a particular area of knowledge. Ideal as support for classes with workshop style, after a lecture or reading of a didactic material in order to promote dynamism and playful learning in groups, including interpersonal interaction and competitiveness. This game is effective for content review or after a lecture to check if the class well assimilated content and consolidated information transmitted during class in a dynamic and interactive way.

Elements and Rules of the Game

Before the game starts, the teacher, or intermediator, divides the class into groups and configures some parameters. In the setup screen, the teacher informs the maximum number of points to win the game (the game is over with a winner when any group achieves this specified number), the number of groups in the classroom and the maximum time in seconds for the group to think of the response after they see a new hint. Figure 1 depicts this pre-configuration screen. After setting these parameters, the teacher starts the game by choosing one of the difficulty level buttons, which categorizes the questions, or the "Random" button that will randomly select a question of any level.

FIGURE. 1
SETUP OR PRE-CONFIGURATION SCREEN FOR THE GAME.

Each group in the game is represented by an avatar image. Each question is called a card and consists of one or more possible answers and a set of hints to help students remember the hidden answer, or one of the possible answers. The group that answers correctly earns the points, which depend on the number of hints revealed. When students answer correctly after only one hint, they get the card's maximum possible points.

The game avoids repeated cards and ends after it displays all the available cards or when a group reaches the maximum number of points.

Figure 2 shows a countdown clock indicating the remaining time for the group to think before attempting to answer, and a button to pause the timer. When it reaches zero, the turn of the current group is over, and the game asks the teacher to change the group. The teacher can change the current group any time to have more freedom and control. The same figure also shows the level or category of the card, a textbox to enter the answer, and buttons to change group, check response, options and skip.

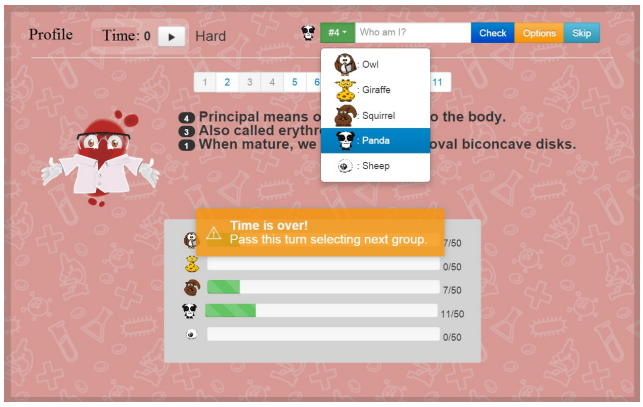


FIGURE. 2
GAME MAIN SCREEN.

Each round, the group that is currently playing has its mascot indicated in the center top of Figure 2, in this case a panda. The students of the current group attempt to give the correct answer after reading a new hint. Each hint is displayed when you click one of the numbered buttons in the center of the screen. As the question difficulty decreases with the increase of the hints read, the reward obtained after answering correctly decreases accordingly, such that if the students answer after two hints they will earn more than it would after the third hint.

The group says the answer to the teacher, who verifies that if it is correct by typing it in the text field on the top of the screen and pressing the "Check" button. If right, an alert will appear informing the acquired points. Then the game loads the next card data on the screen, including changes in the ranking, displaying the progress bar format and number of points for each group. When the first group achieves or exceeds the maximum points, the game displays a message informing the winner of the game and the final ranking, ending the match.

Prerequisites and Data

The game runs in a Web Browser that can be displayed in a classroom environment using a multimedia projector and a computer with Internet access to retrieve data from the cards database. However, there is a standalone version also available without internet requirements. The organization of groups and classroom is the teacher's responsibility, as illustrated in Figure 3.

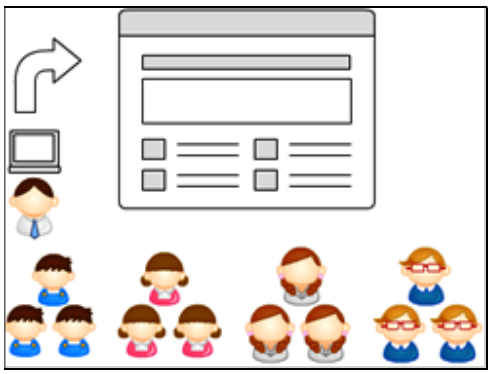


FIGURE. 3
CLASSROOM ORGANIZATION: GROUPS, TEACHER AND GAME.

In the online version of the game, it retrieves information from the database by requesting data through a Web service that provides it in a *JavaScript Object Notation* (JSON) format to the game.

Design and Implementation

The game was implemented using *HyperText Markup Language* (HTML5), *Cascading Style Sheets* (CSS) and JavaScript in the front end, with the cards loaded from a JSON file provided by a java application through a Web service, as illustrated in Figure 4.

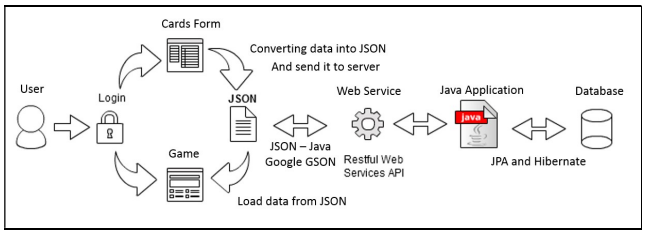


FIGURE. 4
DESIGN AND TECHNOLOGY DIAGRAM.

A complementary Web application is being developed in which the teacher, after performing authentication, have access to the cards form and the game. In the form, the card's data is sent to the server through a Web service and the java application in the server side saves data in the database.

The teacher can enter more than one valid response in the form with at least five hints and the difficulty level, which allows the categorization of the cards if the teacher wants to control which of card will follow based on difficulty. Once the teacher launches the game, it requests information to the Web service, which provides the cards set in JSON format created by the current user, to ensure that teachers are responsible for the edition and use of their own cards, and if the database is empty, the game loads a standard set of cards from a file as demo.

CASE STUDY

By the end of the term, the research group conducted the case study for this digital game in a Hematology Fundamentals course, in order to evaluate the applicability and relevance of the use of this game in the learning process.

Implementation in Classroom

In a classroom with 14 students divided into 4 groups (2 groups of 4 students and 2 groups of 3 students), the gameplay was organized by the teacher in a way that gave each group a chance to attempt to answer at least one card from each category. The cards were associated with the following subjects: red blood cells, white blood cells and platelets.

This game motivated the students to discuss and exchange knowledge on the subjects approached by each card. There was an increase in students' engagement during the game prompted by competition between teams. The challenge in this game proved to be an effective motivator, so that the groups used every second of their available time to think and discuss carefully in order to avoid wasting the chance to give the right answer. Once they understood the dynamics of the game, students began to collaborate without hesitation in the responses and challenge other groups, creating a competitive and fun learning environment.

Feedbacks from students

At the end of the application, students answered a questionnaire to evaluate the dynamic and application of the game, which was well accepted and adopted by the professor as a study and content review tool. The participants also pointed out suggestions for the application technical improvements (errors, game flow and visual) and multi-platform use (Tablets, Smartphones, and Web pages).

After finishing the case study, the questionnaire generated useful data to validate the application as its main objectives: an effective content review tool and the viability of intervention in classroom with a Gamification proposal [8]. The following section will give a more detailed description of this work results.

RESULTS

To check if the application of the game was successful, we monitor the students' behavior and learning. In addition, after the case study performed in class, they answered a questionnaire with eight questions in order to check the

consolidation of knowledge and possible doubts about the approached contents. This practice allowed evaluating the level of the content assimilation and the need for possible adjustments in the game. This case study was analyzed using a qualitative and quantitative evaluation. The qualitative assessment consists of questionnaires with questions about the application, interest and understanding of the activities proposed in the game. The quantitative evaluation was composed of objective questions related to the game topic - Hematology Basics - aiming to measure the absorption of the presented content. The following subsections will address these evaluations.

Qualitative Evaluation

In the qualitative assessment, there were questions about the positive and negative points of the game, difficulties encountered while playing it, suggestions for improvements and interest in using games in other courses.

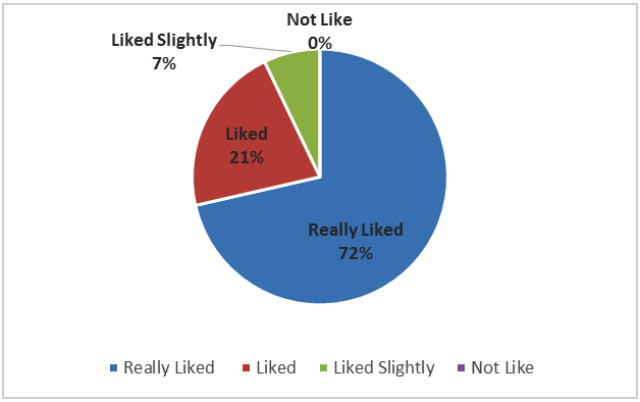
On the positive points, it is possible to highlight the following reports from students: "*..., interactivity; dynamic; interface, advice systems; gameplay; team play; entertaining and didactic way to review the material; diversity of content; elaborated questions; covered the entire content of the course; creativity; and competitiveness*". Regarding the negative points, some students stressed: "*... very specific response; short time to play the game; lack of time control; small font size; should have a team per round; players turns should change automatically; difficulty*". For the second version of the game these points are being implemented.

Regarding the suggestions to improve the game content, students highlighted three points. The first is to establish rules, the second is to provide photos assisting textual hints, and the third point is to improve the hints of the game. However, regarding the game media or format, the same students highlighted two points. The first is to put an automatic control of groups' turns and the second is to provide a version for the Android operating system. These suggestions will be additional features implemented for the second version of the game.

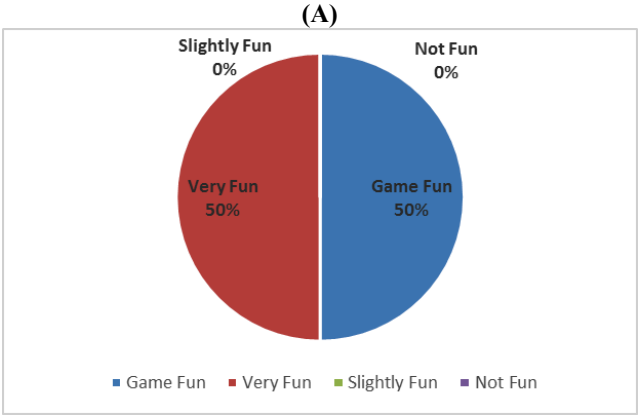
Another question was applied to the students: "*Would you like to use games to learn other subjects? Which ones?*" The subjects mentioned by students were: Pharmacology; Biochemistry; pathology; Microbiology; physiology; parasitology; Kinetics; Immunology; Protozoology; Neuroscience; Cell Biology and Biochemical Analysis. A particular student, for example, reported as follows: "*... In the various disciplines, it is possible to make this more didactic interaction*". And another student reported, "*... It would be interesting if all areas could have games like this to facilitate learning*".

Quantitative Evaluation

The data in this case study was also analyzed statistically, showing that 72% of students reported that they really liked the game, 21% said they liked it and 7% said they slightly liked the game. None of them reported they did not like the game (Figure 5a). Among these students, 50% considered the game fun, while the other 50% considered it very fun (Figure 5b). None of them reported the game was slightly fun or not fun.



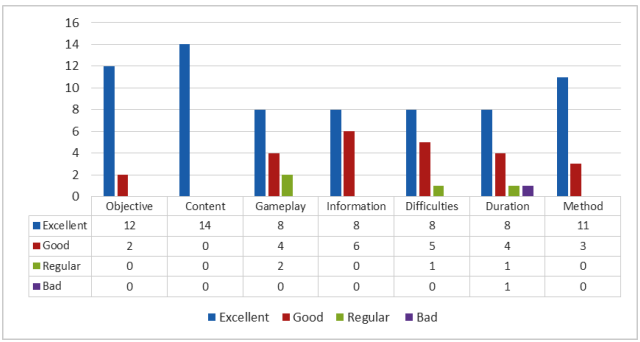
(A)



(B)

FIGURE. 5
(A) SATISFACTION LEVEL AND (B) FUN LEVEL.

We also questioned how students would rate the following items of the game: objectives; content; gameplay; information; difficulties; duration; and method. For these items, we asked students to choose a score level such as Excellent, Good, Fair or Poor. The graph in Figure 6 shows these results.



	Objective	Content	Gameplay	Information	Difficulties	Duration	Method
Excellent	12	14	8	8	8	8	11
Good	2	0	4	6	5	4	3
Regular	0	0	2	0	1	1	0
Bad	0	0	0	0	0	1	0

FIGURE. 6
EVALUATION OF GAME ITEMS.

As we can see in Figure 6, regarding the objectives of the game, 85.7% of students rated it “Excellent" and 14.3% as “Good”. 100% considered the game content “Excellent”. 57.2% rated the gameplay “Excellent”, 28.4% “Good” and 17.4% “Regular”. In the evaluation of the information presented by the game, 57.2% affirmed it was “Excellent” and 42.8% said it was “Good”. In evaluating the workshop degree of difficulty, 57.2% rated it “Excellent”, 35.7% “Good” and 7.1% “Regular”. In the duration evaluation, 57.2% considered “Excellent”, 28.4% “Good”, 7.2% “Regular” and 7.2% “Bad”. The duration was the only item with a bad evaluation. This percentage was as expected, since the students mentioned that they wanted more time to play the game. Finally, the last item was the evaluation of the method, 78.5% rated it “Excellent” and 21.5% “Good”.

Hence, the results obtained in the execution of this empirical study, through qualitative and quantitative evaluation were satisfactory. The students had excellent participation in the activities and reacted generally in a solicitous manner. By analyzing these results, we noticed that the developed and applied game has the potential to be a teaching method applicable in different areas and levels of education for development and enhancement of knowledge approached in classroom.

Limitations and Threats to the Validity of the Study

Due to the characteristics of the case studies in general, this work is also subject to the limitations of this type of research. We recognize that one problem is the lack of information about students’ knowledge prior to their participation in the game play. This problem becomes worst with the fact that there is no control of the groups, making impossible to analyze differences in level of knowledge among students.

In a case study, we collect information about a phenomenon, so the results are usually difficult to interpret and generalize [3]. In this research, the evaluation of the model was performed during only one course in a federal university by the end of the semester. In this context, to achieve deeper results, we intend to continue applying the game in classroom for other courses to detail the results.

FINAL CONSIDERATIONS AND FUTURE WORK

In this work, we developed a game whose aim was to assist the learning process for the Hematology Fundamentals course through a playful way. The game has levels or categories of questions and the players, in groups, need to identify the answer using available hints.

The game evaluations presented in this article indicate that it has potential to be an effective teaching activity. It is capable to motivate students, serving thus as support of the teaching and learning process in different subjects. By using the game in classroom, students felt more motivated to study the proposed content. We could see that the game positively helped the students learning process. Evaluations were important to identify that the content covered in the game can be expanded, encouraging the evolution in learning different subjects. Future work for the game are improvements in aspects of gameplay, interface, expansion of covered contexts, as well as the development of a Mobile version.

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