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CHUTES & LADDERS: GAME-BASED ENVIRONMENT FOR COLLABORATIVE ASSESSMENT IN COMPUTER SCIENCE EDUCATION

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Abstract

Learning assessment is a daring activity in educational settings. In Computer Science education, freshmen show certain resistance at the moment to develop assessment activities, according to our experience in teaching the first courses. To face such situation, we propose the use of a game-based environment for collaborative assessment. In such environment, students are grouped in teams of 6 people, then each team designs a questionnaire based on a specific topic of the course, according to the directions of the professor. When the questionnaires are ready, teams exchange them by using the "chutes & ladders" metaphor as a computer game in classroom. The game is about reaching the goal in a board of 100 cells, starting in the initial cell and controlling the progress of each player through the roll of a dice. Students must pass a series of predefined questionnaires to advance and respecting the ladders to ascend, and the chutes to descend. In this vein, the computer game is seen as a motivational tool, which can create a ludic scenario for collaborative assessment. Each team solves the other's questionnaire in a game scenario. This paper involves theoretical background, methodological aspects, tests, and results from actual contexts.

Keywords: assessment; learning; game

Resumen

La evaluación del aprendizaje es una actividad audaz en los entornos educativos. En la enseñanza de la informática, los alumnos de primer año muestran cierta resistencia a la hora de desarrollar

actividades de evaluación, según nuestra experiencia en la enseñanza de los primeros cursos. Para hacer frente a esta situación, proponemos el uso de un entorno basado en juegos para la evaluación colaborativa. En este ambiente, los estudiantes se agrupan en equipos de 6 personas, luego cada equipo diseña un cuestionario basado en un tema específico del curso, de acuerdo a las instrucciones del profesor. Cuando los cuestionarios están listos, los equipos los intercambian utilizando la metáfora "chutes & ladders" como un juego de ordenador en el aula. El juego consiste en alcanzar la meta en un tablero de 100 casillas, comenzando en la casilla inicial y controlando el progreso de cada jugador a través de la tirada de un dado. Los estudiantes deben pasar una serie de cuestionarios predefinidos para avanzar y respetar las escaleras para ascender y las rampas para descender. En este sentido, el juego de ordenador es visto como una herramienta de motivación, que puede crear un escenario lúdico para la evaluación colaborativa. Cada equipo resuelve el cuestionario del otro en un escenario de juego. Este documento incluye antecedentes teóricos, aspectos metodológicos, pruebas y resultados de contextos reales.

***Palabras clave**: evaluación; aprendizaje; juego*

1. Introduction

As first-year computer science professors, we have noted with concern that freshmen have some resistance when assessed. To overcome such obstacle, we have carried out a study on ways to evaluate; thus, the form of collaborative assessment promotes a scenario where group assessment exercises are performed, involving the participation of all individuals in an active way.
It is of great interest for the research group to use the appropriate technology for supporting assessment processes in different scenarios. In this case, the computing solution designed as a game, has been conceived as a support tool in the classroom to apply questionnaires in a playful way on any topic following the analogy of the board game of “ladders & chutes”. In this vein, we developed a game-based environment to facilitate the application of questionnaires as a collaborative assessment strategy for the freshmen in Computer Science.

In educational terms, collaborative assessment is a process in which students and the professor agree to clarify objectives and criteria. In this case, students are not necessarily responsible for the assessment, but collaborate in the process of determining what should be assessed and perhaps, by whom it will be assessed. In such scenario, assessment process is a consensual vision about the student's learning and the task accomplished.

Collaboration implies that both parties negotiate the details of the assessment and discuss any misunderstandings that could exist. Given this, students take an active part in the assessment process. When investigating the use of games as a strategy of teaching and learning, we find several experiences in different contexts; in fact, many experiences are focused on the theoretical foundations of game-based learning. However, the experience documented through this paper relies primarily on the basics of game-based assessment.

Playing games is a spontaneous act that humans perform very early; indeed, early years of life can be said to be learned through play; it is not a waste of time as some people could think; because

through the game people know their environment and they associate with it; it can be said that it becomes a first language. A game, being a free and non-routine activity, has the power to satisfy and cheer the player; it is an activity that allows social interaction, and such feature empowers the processes associated to collaborative assessment.

Using software engineering, we have designed a game-based environment to facilitate collaborative assessment processes. In such environment, first-year students of Computer Science can design in teams, a series of questionnaires focused on specific topics under the guidance of the professor. The dynamics implemented in classroom makes these questionnaires can be shared through the defined teams. For this purpose, a questionnaire editor is used by the students.

When all the questionnaires have been defined following the instructions of the professor, the next step is putting them into execution through the game. At this point, teams are prepared to execute the questionnaires by using the game.

In classroom, students in teams play the "ladders & chutes" computer game. In a board of 100 cells, each student advances in turns by using a dice. When a student's mark is in a common cell, a question is raised; each team solves the questions to advance in the game. In addition, the game has shortcuts to reach the final cell as a ladder to ascend into the board. In contrast, there are some traps when a student's mark is in a chute, in such case, the student's mark descends in the board.

With this, there are two ways of competition: the first one is an inner competition in the team, because each student must reach the final cell to win the match. The second one is a general competition, because teams are trying to finish the match by separate. In such way, exist several ways to assess learning in a classroom. Professors can make changes to the dynamics of the game to use it as an assessment strategy.

In actual contexts, the computing solution was used in a first course of Computer Science in the Systems Department at the University of Nariño. The selected course was Programming Fundamentals, and the topics covered by the questionnaire design were related to function declarations, arrays, loops and arithmetic-logic expressions. After playing with the computing solution, a survey was applied. The results of the survey show a favorable environment when students use the game as an assessment tool. The students expressed their interest in applying such kind of strategies to assess their learning, in special when they can create questionnaires to be deployed in a classroom.

2. Theoretical background

One of the important aspects to consider for the development of this work is collaborative learning. Cooperative learning is a group of teaching strategies that engage students to work collaboratively to achieve common goals. Cooperative learning was developed to increase student participation by providing leadership and experience in group decision making. At the same time, it is proposed to give students the opportunity to interact and learn with students from different cultural backgrounds, skills and previous knowledge.

Cooperative learning methods require that professors and students assume different roles from those found in traditional classrooms. In common classrooms, professors are the center of activity and commonly use teaching in a generalized way, to disseminate information or to explain skills. Also, in such scenarios, students are often passive and spend most of their time listening or taking notes. Some researches indicate that passive students learn less than those who are more active (Pritchard, 2008) (Wittrock, 2000).

With this, it is understood that the fundamental principle of this work is the collaborative learning; however, the initiative of the research group to do this work is focused in one aspect of the educational scenario, that aspect is assessment.

James (2010) states that the objective of assessments may be firstly, to measure the actual level of student knowledge; and secondly, to measure their ability to relate and integrate acquired knowledge. On the other hand, Ebel and Frisbie (2009) affirm that the objective of the assessments is to evaluate the students' achievements to motivate and guide their learning processes.

However, it is thought that assessments can also be used as learning mechanisms, especially if collaborative learning activities can be included in them. Assessment as a mean of teaching-learning is faced from collaborative strategies to raise autonomous individuals in a specific domain. The assessment of knowledge is difficult when the legitimacy of values and common patterns are in crisis (Chaiklin & Lave, 2001).

Nonetheless, in an assessment process where students are involved in the process and the context, the results may be different. Assessment is a process that evaluates the student's performance through his / her own peers so that feedback is managed from their own perceptions and with their own languages. The professor plays a facilitator role to achieve that the students get involved in the process with favorable results.

To effectively implement any kind of cooperative assessment, teams must be organized in advance. The objective is to create teams of four or six students who have roughly the same skills. Slavin (1995) suggests that four is an ideal group size, but all depends on the circumstances of each actual contexts. A research indicates that mere grouping does not ensure trust and cooperation (Martin-Cuadrado, 2011).

An important task in planning is to design consolidation activities that help students learn to accept and trust others. The purpose of group consolidation exercises is to help students present themselves, develop a group identity, and recognize peers who can collaborate. Finally, developing a collaborative activity requires the definition of a series of characteristics such as: the nature of the collaborative task and the environment (Bannon, 1994).

Kagan and Kagan (2015) have defined four basic principles that must be present in any collaborative activity: simultaneous interaction, equal participation, individual responsibility and positive interdependence. These principles were considered at the moment to develop the proposal in this work.

3. Deploying the solution

Once the applications are installed, students form teams of up to 6 people. In this way, each team can start the configuration of questionnaires using the application "Ascender – Editor de Cuestionarios". The initial screen shows one entry per session. Such screen is shown in Fig. 1.

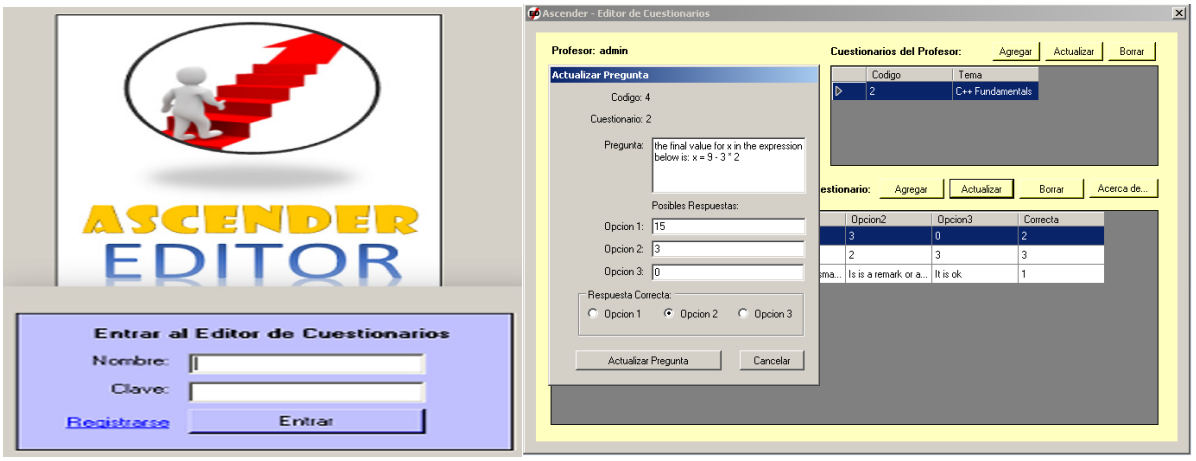

Figure 1. Entering the editor tool and configuring a questionnaire. (Source: the authors)

When entering, it is feasible to handle all the information of all the registered teams. For each team, it is possible to create their questionnaires and these with their respective questions. Fig. 1 also shows the screen with its options to configure a questionnaire by adding questions.

The management of the questionnaire editor tool is very intuitive. Three sections are presented: Professors, Questionnaires and Questions. The Professors section can only be observed when entering the System Administrator, otherwise any team will not be able to see this section and only see their questionnaires and questions. Each section has the same functionality.

There are buttons for Adding, Updating or Deleting the information that appears in the logs of the grids. To work with a specific information, it is necessary to select it by clicking with the mouse. Once the questionnaire is set up with its questions, the code that was generated for that questionnaire is the entry point to execute such questionnaire in the game. For playing the game, the application called "Ascender – Una Aventura de Aprendizaje" is activated, which shows the following welcome screen ant its transition for asking for the questionnaire code.

When the questionnaire is loaded, it initiates the game based on a route between ladders and chutes. The object of the game is to reach the goal –cell 100–. It is required that a minimum of 2 students are registered in the respective boxes of the team match. There can be a maximum of 6 players for each team. Fig. 2 shows the screen of the main board of the game.

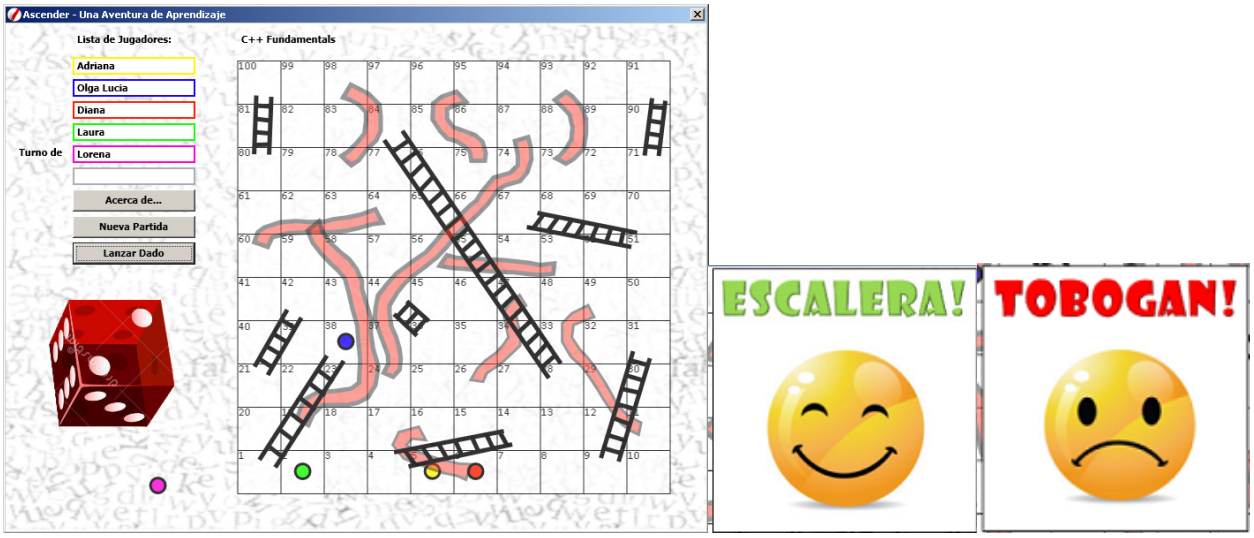

Figure 2. Playing the game and Iconic representation of ascending or descending. (Source: the authors)

The game starts with the registered players, which consists of rolling a dice to determine the progress of each mark of students. When throwing the dice, there are 3 situations: take a ladder to ascend, take a chute to descend, or step on a cell to solve a question of the questionnaire.
The main idea of the game is, in a playful way, to experiment a scenario of questions and answers that have to do with a specific topic.

The situations to be solved are part of the questionnaire formulated by the teams. Obviously, the more questions the questionnaire has, the more random experience will have a match. In the end, the winner is the one who reaches the 100th position. Fig. 3 shows some questions formulated by a team.

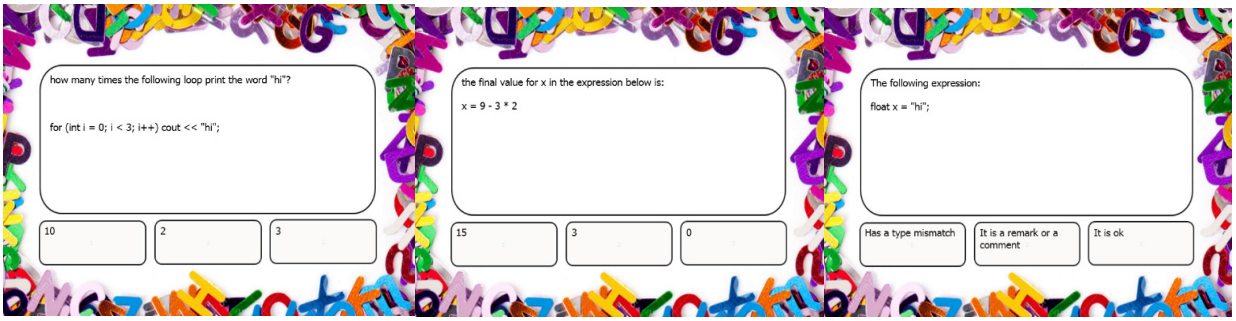

Figure 3. Some questions raised by the game's progress. (Source: the authors)

4. Findings

The computing solution was created by using RUP method in software engineering (Sommerville, 2015). Such a computing solution was tested through a usability study. This study was based on series of tests with different degrees of difficulty. 20 students were required; According to Nielsen, Turner and Lewis (2006), "a small number of users will find most of the problems".

These students belong to the Systems Department. Five teams were formed, each one of 4 students. Each team performed a guided test according to a pre-established process. The experiences were observed and measured by the researchers, measuring the time used in the solution tasks; In addition, special attention was paid to observing how the teams manipulated the tool in terms of functionality.

After completing each guided test, each team responded to a survey considering the experience with the computing solution. Each team followed the instructions to interact with the computing solution. Then, they began with the usability test. The usability test is based in the following questions:

Q1. Evaluate the degree of functionality of the computing solution ({1} Poor, {2} Good, {3} Excellent)
Q2. Did you like how the computing solution handled the information? ({1} It was chaotic, {2} It was confusing, {3} It was neat, {4} I definitely liked it)
Q3. How accurate is the computing solution? ({1} Very inaccurate, {2} inaccurate, {3} precise, {4} very precise)
Q4. In general, how easy was it to use the computing solution? ({1} Very difficult, {2} Difficult, {3} Normal, {4} Easy, {5} Very easy)
The results are shown in Table 1, and graphically the results are depicted in Fig. 4.

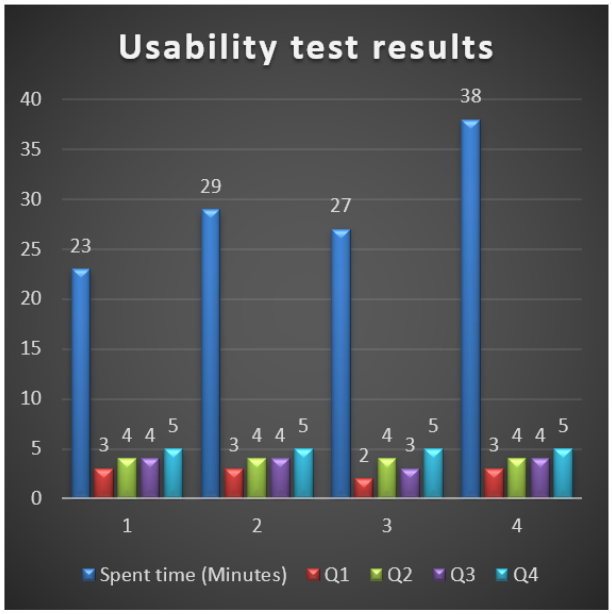

Table 1. Tabular results of the usability test.

Team	Spent time (min)	Q1	Q2	Q3	Q4
1	23	3	4	4	5
2	29	3	4	4	5
3	27	2	4	3	5
4	38	3	4	4	5

Source. This research.

Figure 4. Results of the usability test with tabular values. (Source: the authors)

5. Conclusions

The investigation of alternative ways to assess knowledge in Computer Science education promotes the development of scenarios about applied technology. Accordingly, a relevant academic contribution is generated in the sense of triggering a series of research projects in which computing

solutions help to facilitate assessment processes. With this idea, this research provides an example of how to create a computing solution in the field of education where students can experiment with collaborative assessment.

Game-Based Learning is an educational methodology that uses games as a motivation and learning tool. It is a deeply active, social, meaningful and experiential practice that has points in common with learning by doing, problem-based learning, project-based learning, peer learning or living education.

In the case of Game-Based Learning, the game is a tool that is used as a whole (not in parts). A game is a finished product on which an author, an editor, a developer, an illustrator, some testers, etc. have worked. It has some rules, some mechanics, some materials and a narrative that is coherently linked with a play objective. The raw materials of the Game-Based Learning are these playful games, which are sought, used and expressed their educational potential to obtain a specific objective. If there is no objective, there is no Game-Based Learning.

The implementation of a computing solution based on the proposed usability concept is a valuable contribution in the sense of demonstrating that such proposal is feasible. Consequently, the main objective of the research was successfully achieved because of the findings in the usability test. The set of resources related to the construction and deployment of the computing solution is available for download; This is for those who want to continue with the new experiences in this matter.

In technical terms, it is important to note that the source code of the computing solution is available for download. Therefore, people who are interested in developing a computer solution on the subject could consider this tool as a reference. This is a contribution to the developer community. In addition, it is also important to point out the relevant role of the students to create the questionnaires. They demonstrated motivation in such tasks.

This computing solution cannot replace the professor's labor in assessment; contrariwise, the computing solution serves professors to complement their assessment activities at work.

6. Recommendations

In summary, the Game-based Learning puts in the hands of the professors a tool that can be used in very diverse ways and to achieve different ends. It is very flexible, adapts to the needs and possibilities of each professor and each student, is easy to use and does not require a complex training, or a large investment.

As a recommendation, professors can use this toolset to articulate any kind of questionnaire, no matter the topic that is taught. First off, professors need to create a questionnaire with an enough question stack to get the best results in the deployment of the game within the classroom. In addition, professors can share their questionnaires to be updated and getting feedback.

7. References

Journal papers

- Bannon, L. (1994). 'Issues in Computer-Supported Collaborative Learning', Proceedings of NATO Advanced Workshop on Computer-Supported Collaborative Learning. Italy: Claire O'Malley.
- James, M. (2010). 'Educational Assessment: Overview'. In E.Baker, B.McGaw & P.Peterson (eds) International Encyclopedia of Education: Third Edition, 3(1). Oxford: Elsevier. 161-171.
- Martín-Cuadrado, A. (2011). 'Competencias del estudiante autorregulado y los estilos de aprendizaje'. Estilos de Aprendizaje, 8(8), 136-148.
- Nielsen, J., Turner, C. & Lewis, J. (2006). 'Determining Usability Test Sample Size'. International Journal of Ergonomics and Human Factors, 12(3). 3084-3088.
- Wittrock, M. (2000). 'Knowledge Acquisition and Education'. The Journal of Mind and Behavior, 21(1). 205-212.

Books

- Chaiklin, S. & Lave, J. (2001). Estudiar las prácticas: perspectivas sobre actividad y contexto. Buenos Aires: Amorrortu.
- Slavin, R. (1995). Cooperative learning: Theory, research and practice. 2nd ed. Boston: Allyn and Bacon.
- Ebel, R. & Frisbie, D. (2009). Essential of Education Measurement., Fifth Edition. New Delhi: Prentice-Hall.
- Pritchard, A. (2008). Ways of Learning Learning Theories and Learning Styles in the Classroom. 2nd Edition. London: Routledge.
- Kagan, S. & Kagan, M. (2015). Cooperative Learning. San Juan Capistrano, CA. Kagan Cooperative Learning, CA, USA.
- Sommerville, I. (2015). Software Engineering. 10th Ed. USA: Pearson.

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