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Analysis of design patterns for educational application development: Serious Games

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Abstract

Learning based on serious games is an emerging field in education, product of the proliferation of technological aids in the educational field and the necessary opening to new didactic methods that support the educator in the complexity of joining the transmission of knowledge and in the training in competences that comprise the learning process. In recent years, there has been a remarkable set of experiences in applying game-based learning to formal training scenarios, particularly in the higher education environment, which have encouraged the attempt to develop a working tool designed for the development of one of the most complex competences of the learning process and, at the same time, contradictory to individualism: teamwork. In this study, a serious game has been designed, with the aim of promoting and analyzing the development of teamwork skills. In this serious game, students have to solve a problem whose solution depends mainly on the ability to negotiate among group members.

Keywords: Analysis of design patterns; Serious game; Teamwork skills.

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1. Introduction

The current evolution of the Knowledge Society requires a change in mind among teachers for adapting new teaching methodologies, based on the possibilities offered by the digital environment to teach in a different way, adopting new ways of learning of "digital natives" [1]. Teaching differently requires the use of active and cooperative methodologies for a world full of complexity. And precisely in order to work in a cooperative way, it is necessary to develop the competence of teamwork, which exists when the members of the group perceive that they are united among themselves (positive interdependence) so that they cannot succeed without the others succeeding (individual and group responsibility) [2], and there must be an interaction that takes place when the members of the group share resources, help, support and learn social skills that allow them to act as part of the group [3]. To do this, groups must talk about the process, and how they will achieve the objectives. Finally, they must detect which actions of the group members help or do not help and decide which behaviors to change, which is known as group self-assessment.

According to [4], cooperative learning is understood as "the ability to operate, from a teaching point of view, with small groups of students working together to make the most of their learning and that of their fellow students, so that each can build up his or her knowledge if they count on the collaboration of their peers". It is precisely in this area that the so-called serious games are circumscribed, which promote understanding, integration and application of concepts, allowing for improved performance, unlike master classes in which the student is merely a receiver of information [5]. From this perspective, the participation of students in virtual environments, where they have to put their learning into practice, implies a reinforcement of the teaching-learning experience [6][7].

The above makes full sense taking into account the new scenario of universities, which are committed to encouraging teachers to improve the quality of teaching in accordance with the new contextual coordination of teaching action within the Asian framework of Higher Education, in which it is necessary to develop teaching innovation programs that stimulate and recognize the participation of teachers in activities that develop new teaching-learning methodologies, which in this case would focus on promoting the development of generic skills in students through the design of learning activities based on Serious Games [8].

The use of the Serious Games is justified by the possibility they offer to simulate reality, which makes them a key tool for promoting learning and transferring knowledge, stimulating the participation of students in virtual scenarios, which undoubtedly encourages the generation and management of expectations, starting with the willingness of participants to learn [9].

1.1 Specific project objectives and assumptions

As a research hypothesis, it is argued that teamwork improves with experience in such a serious game. To this end, it has been taken into consideration that learning scenarios mediated by ICT, based on interactive digital technologies, can favor the conditions for the implementation of new active methodologies, demanded from all educational forums: various modalities of open learning become viable, with flexible educational offers, valid for both face-to-face and semi-presential or distance environments [10][11].

2. Methodology

The following four dimensions of analysis [12] [13] [14] [15] are considered in the method: a) the specific aspects of the learner: including profile, role and competences, b) the pedagogy used: associative, cognitive and social-situational, c) the representation selected for the design of the game: fidelity, interactivity, degree of immersion, and d) the context in which the learning takes place: environment, access to learning and support resources.

On the other hand, just as play has always been an inherent activity in school life, especially in the field of non-formal or informal education, the necessary step towards the integration of play into formal education has not been addressed, often being relegated as an activity that distracts from the educational purpose, wasting its instructional potential. [16] points out that, although learning is based on the motivation of students by their teachers (empowerment) and a combination of the ability to solve problems and gain knowledge about reality, participants in a game play want to satisfy a social need and not to solve the challenge of a game. Thus, it is often obvious that the

practice of digital games in the classroom is not only the implementation of knowledge learning, but also the application of behaviors in order to stimulate the broadest cognitive set of the knowledge-attitude-perception triangle.

Finally, the aim was to contribute to an academic approach in the field of pedagogical design of serious games in the classroom, given that in the academic field most studies to date have focused especially on the study of technological interaction and, to a lesser extent, on pedagogical and student support issues [3].

2.1 Description of the method used for software design

In relation to the design of the serious game it is worth mentioning that an instructional design was approached in order to meet the organizational and user requirements, taking into consideration the following parameters [14]:

- The tool must be easy to use and understand for students of any kind of training or previous knowledge.
- It must propose tasks that require collaborative exercises between several players.
- As for the design of the software, the following features were chosen:
  - It is supposed to be a competitive arcade game.
  - Confusing elements in the language, graphics or design must be avoided, so a bi-dimensional style was chosen.
  - It must avoid elements alluding to social or ethical values that can provoke unexpected emotional reactions from the players.
  - A design with simplicity of perspective must be chosen.

Consequently, it was decided to use a design based on simulation experiences (Simulation Experience Design Method) that have been demonstrated as training tools with a high potential for the implementation of skills by the player, both by the combination of the "real time" factor and by the return of results for the player [7].

The result was the design of a serious game that simulates an air traffic control activity, in which players have to combine a series of planes in flight, which have different routes and duration of flight, to optimize the use of airspace (measured in time) and avoid any collision between them. Each team member represents an airline and is responsible for 2 planes, so each team must place 16 planes in the airspace. They have to find the best possible solution to minimize the total flight time of all their aircraft.

The flights of each airline have the same color and all of them can be moved along an axis representing the time of flight. Each plane is a segment, whose slope and length represent, respectively, the route and the duration of the flight. Figure 1 shows the initial problem.

As a result, several combinations of aircraft placement can be given to avoid collisions between them. For example, the Figures in 2 represent two possible solutions to the initial problem. Logically, the best solution is the combination of aircraft that allows the shortest total flight time.

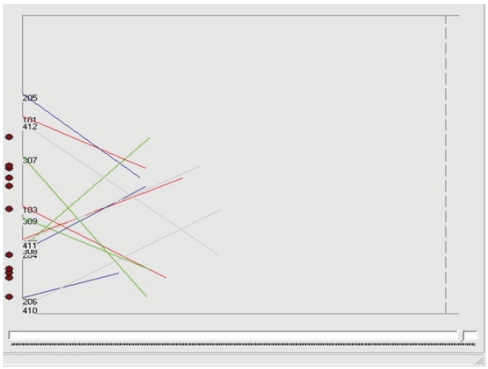

Fig. 1. Initial problem posed by the game

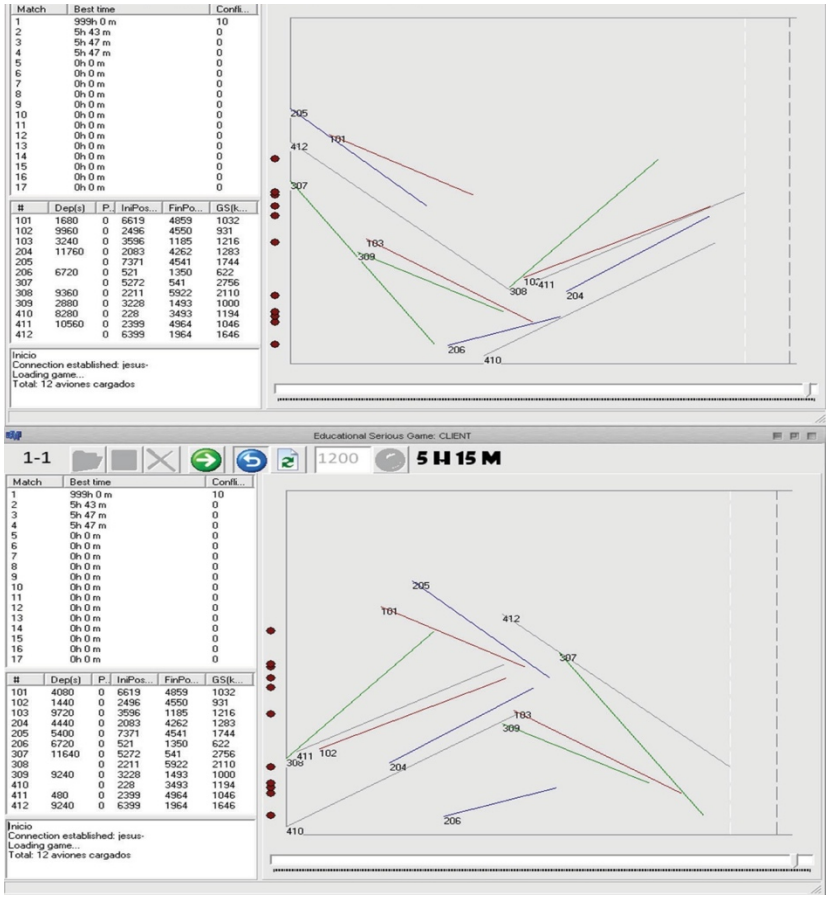

Fig. 2. Possible solutions to the initial problem

In this way, each team member has to negotiate the distribution of the aircraft within the airspace with the other team members, as their best solution is necessarily supported by the solutions of their group colleagues, in line with the basic idea of teamwork competence. Since the best solution is known by the teachers, it is possible to know the number of groups that actually manage to obtain it through the negotiation process.

2.2 Description of the characteristics of the sample

The project is carried out during the period from October 2018 to March 2019, with students of Early Childhood Education Degree from 3 universities in India. The initial sample was 1,236 students, of which, the number of valid participants was 958 due to lack of attendance or other circumstances.

2.3 Description of the data collection process

The data collection was carried out in several sessions. In the first session, the tutorial of the game was presented and the subject was confronted with the execution of the first individual games. In the second session, the subjects got familiarized with the functioning of the serious team game, and the scoring systems were clarified, as a previous step to the execution of the first team games, but in a non-competitive way between the different teams. The third and fourth sessions are entirely dedicated to team games, which allows to obtain the data of the obtained solutions.

Since the main objective was the development of collaborative working skills, it was assumed that the students could obtain the best results only if the team of players resorted to communication, negotiation and cooperation techniques among themselves. In order to analyze it, the solutions obtained by the 14 groups in the first round of play (without training) were compared with the participants in the last game (after training). In addition, a Chi-square test was used to analyze the two categorical variables: the experience of the serious game (with or without previous training) and the obtaining of the best result of the game (best time with respect to other recorded times) and, consequently, the improvement in the teamwork competence.

3. Results

The data of the 14 groups are shown in the following contingency table (Table 1). At the top (without training), only 2 groups performed best. In the final game, after training, 8 teams got the solution.

Table 1. Results by group.

TRAINING			
	Without	With	**Total**
Best Time	4	7	11
Other Time	12	5	17
TOTAL	**12**	**12**	**24**

The Chi-square value was 6.14 with 1 degree of freedom, so it is statistically significant for a significance level of 0.05. Therefore, the null hypothesis of independence between training (the experience in the serious game) and solution time, which measures the improvement of teamwork skills, is accepted. In addition, 0% of the cells had an expected frequency of less than 5, so the test results can be considered reliable.

4. Conclusions

This study aims to show that students who have been trained through the Serious Games method are more willing to collaborate and establish teamwork actions, thanks to the additional motivation that solving a challenge like the game brings. This is an encouraging finding although further research is needed to determine how much time of use of the Serious Games is necessary to achieve the objectives of the subject in terms of acquisition of skills. In this way, the results show if the effectiveness of Serious Game is compatible with the number of hours that its practice requires in order to achieve the objectives of the subject by the student.

Another of the conclusions of the experience, after consulting the participating students, is that indeed the motivation to participate in this type of unusual activities for regular formal training is not only very high, but also the willingness to participate again in similar activities in the line suggested by [4].

From the result of applying the analysis methodology of [16], it is concluded that, in relation to the specific aspects of the trainee, the competence of teamwork stands out. Teamwork in this study is understood as the capacity of students to actively collaborate in team tasks, fostering trust, cordiality and orientation to the joint task. Further analysis would be needed to find out the implications of the playful activity in the acquisition of other skills since, for example, other elements worked on in this activity involved, in addition to collaborative activities, the application of strategic and innovative thinking. Furthermore, the proximity of the training experience to the evaluation of the exercise may have a multiplier effect on the level of performance of the participants that may lead to a bias in the conclusions.

As for the pedagogy used, it has focused on those activities that are eminently communicative in nature [17][18], activities that refer to the use of dialogue to resolve conflicts that arise during the resolution of tasks, so that the social dimension is based on the exchange between students. In relation to the third and fourth dimensions, it should be noted that the selected representation of an air traffic control has facilitated immersion in the game of the players,

with the real time factor facilitating interactivity between group members in a very dynamic learning context of short duration

While there is an important tradition in the study of Serious Games applications in commercial or professional training environments, the study presented in this paper contributes to the applicability in formal training environments for the development of generic collaborative skills among students.

More generally, this study aims to contribute to a better understanding of the potential of simulation games in motivating affective experiences in users. Teamwork competence is required in many learning environments and a game-based system provides the ability to learn, practice and assess competence in a way that is not easily achieved by traditional methods.

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