Platform for Improving the User Experience in the Creation of Educational Multiplayer Video Games

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Abstract

Students' motivation is one of the factors that directly affect academic performance. In recent years, teachers are looking for ways to motivate students during their training period. For example, making use of slides, videos, films, comics or games to increase students' motivation to improve their learning experience. Some research works have revealed that multiplayer games which include cooperation and competition, among other factors, are an extraordinary tool for enhancing students' motivation. Current alternatives make it very complex for teachers to create multiplayer games for their students. The definition of the game requires many configurations and even technical knowledge. This research proposes a new platform that allows teachers to create multiplayer video games in a simple and fast way, improving the game creation process over current alternatives. The resulting games are also designed for to improve the student experience, and make it fun. These games do not only include trivia questions, but also use functional mechanisms from video games. The design of the generated games allows students to master the games in a short period of time during their classes.

Keywords

E-learning, Gamification, Multimedia, Usability, Videogames.

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I. Introduction

FROM an early age, we use games as a tool to teach and train students in different areas. Traditionally, as children grow up and were trained in more complex areas, these types of games decreased and were replaced by other teaching methods. In recent years the advancement of these technologies has boosted the increased use of games applied to training in different forms such as simulators, video games or other types of training environments [1]. In the educational field, games can be used to provide greater immersion in the subject matter being learned to [2], increase motivation [3], [1] improve satisfaction [4], increase entertainment, creativity or autonomy [5]. In some cases, even commercial videogames have been used in teaching [6]. We can establish different classifications of the games applied in education. On the one hand, there are video games created to deal with specific content. On the other hand, quiz-type video games provide teachers with a greater possibility to customize or configure the content.

There are other types of video games that are purely educational, since they have been created with the purpose of making players learn. We can consider these types of applications to be video games if they include the characteristics of video games. Depending on the researcher, there may be a fine difference between a video game and an application that applies gamification. The difference between an application and a videogame is that the video game places the player in a virtual environment using 2D or 3D graphic resources. By gamification, we mean the inclusion of typical elements of a game to something that is not a videogame to motivate the people involved in the activity [7]. In practice, there can be a big difference between using gamification in the classroom and using a videogame as part of the educational process.

The effect of the increase in student motivation derived from the use of quiz game creation platforms is proven in the studies analyzed in the related work. The quiz platforms are increasingly used by teachers, due to several factors:

- They can be applied to almost any subject or content.
- The preparation time for the content is reasonable.
- The level of knowledge required by the teacher to configure the games is low.

In contrast, we believe that the level of motivation enhancement in a pure quiz game will not always be as high as in a more "traditional" video game, partly because quiz games are so simple that they do not include many of the features that positively impact students' motivation [8].

Video games used in education can include several factors that positively impact motivation [8]. Some of these features have been pointed out in several research works.

- **Internal interaction** among players, so that teams can be established or they can encourage cooperation [9], [10] ,[11].
- **Synchronization** between players so that they perform synchronous or asynchronous actions in the same scenario.
- **Roles** created to facilitate iteration and dependencies between players, e.g. a doctor, a builder, etc. [12]
- **Resources** (collectible objects in the game) can be finite or non-finite, consumable or non-consumable. These objects should be

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related to the educational context of the game [13].

- **Scores,** including a quantitative scoring system that motivate and stimulate competition [14].
- **Challenges,** there must be clear objectives that players have to meet and challenges that get progressively difficult or little repetitive, so that the results cannot be predicted [15], [16].
- **Rewards** (a way to stimulate players). Rewards normally make you earn points in a ranking or receive some distinction, objects or badges that provide satisfaction to students.
- **Artificial intelligence,** contributes positively to the immersion in the game.
- **Interoperability** (consideration of hardware requirements), so that the game can be used in an agile way in an educational environment.

Some researchers highlight several important factors to increase students' motivation. One of the factors is the possibility of establishing collaboration and competition among students [8], [11].

One of the challenges in using real video games in education is the complexity involved in defining their functionality, such as internal interaction, roles, scores, challenges, and rewards. This can make it difficult for teachers to configure video games for classroom use.

This research aims to address this challenge by creating a solution that allows teachers to quickly and easily define a video game with the key elements that have a positive impact on student motivation, as identified in previous research works. The focus is on improving the user experience for teachers in the steps of video game creation process. Additionally, the research seeks to enhance the experience of students when playing video games, ensuring that they can quickly master it within the limited time available in the classroom. After all, a game that is too complex for students to handle is of no use in an educational setting.

II. Related Work

Since technologies are more present and more accessible among the population, the use of these in different fields has been investigated. One of the benefits of this technological development has been in the field of education, which has been used in combination with other educational resources.

Studies have been conducted using video games, analyzing how they can affect the learning process and student motivation. Some of these research works analyze how users are affected by the way objectives are set in the game. Some objectives are set to focus on learning, whereas others focus more on the completion of a specific task [17].

There are research works which analyze how group sizes affect students when they are using competitive multiplayer video games as a means of learning. It also analyzes how learners' cognitive load may increase as the group size increases[10].

Both studies mentioned above have used Minecraft's video game to conduct their analyses. The students' objective was to learn the basics of logic and programming. Evaluations were aimed at acquiring this type of knowledge and focused mainly on studying specific aspects of learning. This game has a version called "Minecraft Edu" aimed at educational organizations so that teachers can develop their own work environments where they can teach subjects such as computer science, project management and environmental sustainability, among others.

Some studies show how gamification strategies in games affect the teaching of specific concepts [18]. This research exposes how certain elements within the games can positively affect the motivation and the perception of the activity by the students. They also expose the difficulty or lack of frameworks which allow teachers to design activities contained in games.

Many video games have been designed to cover very specific knowledge, competencies or objectives. For example, we can find video games for muscle rehabilitation [19] to simulate scientific applications [2] or to learn specific skills such as how to fly airplanes through simulation video games [20]. Thanks to features such as 3D graphics, music, animations and iteration capacity, video games can achieve a higher immersion than other more classical methods.

There are some educational video games that have editors and tools for teachers to configure and edit the content. One of the most famous video games in this category is Minecraft Education [21], where teachers can create maps, mechanics, objects, puzzles and questions, among other things. This version of Minecraft has been used successfully in numerous cases. For example, this was used by more than 100 students in a university environment, to reinforce programming and logic knowledge. A positive aspect of Minecraft Education is that it can be multiplayer and allow competition among students [10].

There are platforms such as Scratch and Roblox, which can be used for developing video games. These do not require in-depth knowledge of programming, 3D modelling or videogame design. An example of Scratch used in the educational field is shown in a study on the subject of English with students with Attention Deficit Hyperactivity Disorder (ADHD) [22]. In this case, Scratch was used to create several mini games which introduced concepts of different topics applied to learning English [23].

Multiple platforms allow teachers to create quiz games. These games include various gamification elements, but they may not be considered real video games and the level of motivation enhancement may be lower compared to other video games. Kahoot is one of the most popular quiz game creation platforms [24]. This tool consists of exposing questions previously configured by the teacher to the students. In each question, several possible answers are exposed, and students individually must select the answer they consider correct. In the case of selecting the correct answer, the game assigns you a series of points depending on the speed with which you have answered the question. Between each question, a ranking is shown to the students which generates a multiplayer and competitive environment. There are many other relatively similar platforms such as Quizizz [25]. Several pieces of research prove that the use of this type of game has had very positive effects on the motivation of students. 90% of students who use it occasionally or frequently reported that they had fun using the system and more than 80% would like to use it in other subjects [26]. Other studies indicate that the use of these tools increased the interest of students by more than 60% [27].

Only a few tools or proposals that enable the creation of video games or educational video games include features that can enhance student motivation. Many so-called educational games are simply quiz applications with some gamification aspects, lacking actual game features or the elements that have been identified in numerous research studies as being able to enhance student motivation. While it is relatively easy for teachers to create questions using such platforms, the resulting products are not genuine video games.

The limited alternatives that allow for the creation of actual video games, such as Minecraft EDU, can be challenging for teachers as they require technical expertise and can make the process of creating a video game complex and time-consuming. Therefore, there is a significant need to create new solutions that can enable teachers to create engaging video games that incorporate the key elements of motivation identified in research studies, but without the technical

challenges associated with existing tools. This would enable teachers to create high-quality educational video games that promote student engagement and learning in a fun and interactive way, without requiring significant technical knowledge. No platform or proposal has been found that focuses on improving the experience of creating multiplayer educational games.

III. Proposed Platform

We propose a platform focused on improving the user experience of teachers in creating competitive multiplayer videogames. With this platform, teachers can configure the game and integrate the questions related to the current session in an agile way. Each game session is configured with a group of questions about a subject. These questions have a similar structure to the questions which are used in applications such as Kahoot, but in this case, they will be integrated within a real video game with game mechanics and rules (Fig. 1).

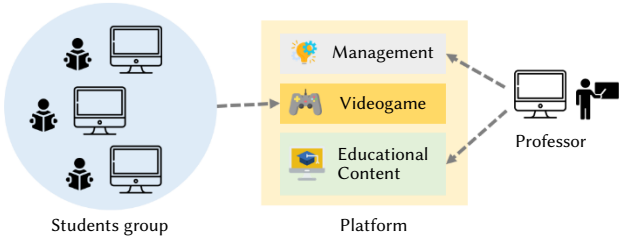

Fig.1. Proposal conceptual scheme.

Another point of interest is the output game created by teachers. The research sets several points to consider in output game design, thinking about increasing the motivation of the students. It has been decided to base the initial idea on the popular game BedWars, a conventional Minecraft mini game in which players must destroy their rivals' beds. The original concept and rules of the game have been combined and adapted to fill the research goals.

It is primarily a real-time multiplayer game. At the beginning of the game, each student starts on his own island. On each island, there is a "block generator" and a "flag." Initially, the islands are separated by a sea. The goal of each student is to move to other islands to capture their rivals' flags and then take the flags to their own islands. The player who captures as many flags as he has set on the game configuration will win the game. To move between the different islands, players must build bridges using blocks. The blocks are collected in the block generators.

The output game has been designed to prioritize the students' user experience. In many instances, students may only have a limited amount of time to play, such as a single class period. Consequently, the game's controls and mechanics must be intuitive, enabling students to quickly become proficient without spending excessive time familiarizing themselves with the gameplay. The design of the gaming experience aims to facilitate the mastery of the videogame, even for those without prior experience.

In addition to the students' user experience, the game must continue to maintain features identified as beneficial for improving user motivation.

Internal interaction among players. The game is designed to keep all players visible on the same map. The game mechanics will also offer the chance to collaborate and compete with other players. The players may also use elements created by other players (bridges).

Roles. The proposed design does not fully include this feature, i.e. there are no players with their own skills which cannot be obtained by another player. The use of roles has as its main objective that students may need the skills of others. In this game, all players have the same skills, and can build bridges if they have enough blocks. In some instances, there could be some players who cannot build bridges, which will help encourage collaboration.

Resources This guideline recommends the use of finite or non-finite resources, consumable or non-consumable and related to the educational context of the game. In this case, the main resource are the building blocks. Blocks are a finite resource that is created by the generators progressively with several new blocks created with each turn. The blocks are a resource, as they can be used to create bridges, which is an essential element of the game. Without bridges, it is not possible to move to other islands. The resources are directly related to the educational context since a question is sent to the student when they request the blocks of a generator. If answered correctly, the student will get some extra blocks.

The design includes a quantitative scoring system, with the objective to stimulate competition among the students. At any time during the game, it is possible to see the number of points that each participant has. In this case, the points are the number of flags that have been captured on other islands and then brought back to the player's island.

The proposed challenges are clear objectives, which the players must fulfill at each moment. In an optimal scenario, these challenges should be non-repetitive and increase their level of complexity. The main challenge is clearly identified - to advance towards a rival flag in order to capture it. This challenge involves carrying out a series of tasks, such as obtaining the building blocks and creating the bridge to reach the other player's island. The fewer flags that are available, the more complex it will be to obtain them, since there are a greater number of players who will go for them. In general, multiplayer games prevent challenges from being presented in a very repetitive way as there are several people involved. Another secondary challenge that the player could face in the game is to "defend" his own flag. Through A game feature that has been included that allows the player to challenge other players to a question, which can be used to prevent them from attacking the player's flag.

The rewards are encouragements that allow players to gain ranking points or recognition. The proposal includes two types of rewards (1) the reward for saving a flag that consists in getting a point for the ranking (2) the reward for answering questions that results in getting extra building blocks.

The current design does not include **Artificial Intelligence**, but research shows that its use can contribute positively to the immersion in the game. In this case, the proposed design is imminently multiplayer, so it is not so critical that non-controllable elements (NPCs) managed by artificial intelligences appear.

Interoperability, the platform has been designed on web technologies, so the hardware requirements are extremely light. The game only requires a web browser for its operation avoiding having to install a program and its subsequent updates and even opening the possibility for students to play on their own devices such as cell phones or tablets.

The output game is played in turns of limited time. In these turns, the player has the possibility to move a maximum distance and perform an action. There are different actions, and it is in these actions that the questions are introduced (fig.2). The more questions that are answered correctly, the more competitive advantage the student will have during the game. The main actions are:

- Move: Each player can move 8 cells each turn. The floor of the map is divided into cells, and they can only move through cells containing land or bridges.

- Collect blocks: If the player moves next to a "block generator" he will be asked a question. He can get more blocks if he answers correctly.
- Building bridges using blocks: This feature is necessary to move from one island to another. The blocks placed disappear after a number of turns, with the aim of encouraging the obtaining of blocks and therefore answering questions on the subject.
- Capture and deposit the flags: By moving the player to the same square as the rival flag, a player is able to capture it. From that moment, the player owns the flag and must deposit it on his own island. Once it is deposited, they will get a point.
- Challenge another player: When two players are close to each other, either of them can initiate a challenge. Challenges send the same question to both players. In the event that either player does not answer correctly, they will be penalized by losing half of their blocks and being transported to their island.
- Collaborate with another player: When two students are close to each other, either of them can initiate a collaboration. In this case, the two players team up to answer a question together and cooperate. If one of the players answers the question correctly, both players will receive an extra number of blocks. In case they answer incorrectly, both would be penalized.

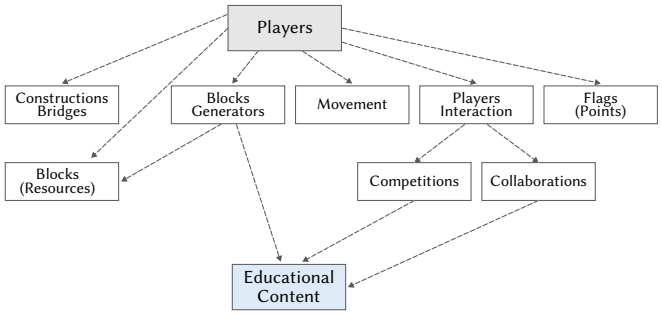

Fig. 2. Gameplay design of the game and tree of actions.

The responsibility for configuring and managing the game rests with the teacher, who must customize various aspects of the game to align with their teaching goals. To simplify the configuration process, our solution includes default parameters, which can be easily adjusted to meet the specific needs of the classroom. Additionally, the teacher can integrate their own questions into the game by specifying the statement and answer choices (true or false). These customizable features enable the teacher to tailor the game to their subject matter and classroom objective. It is possible to set a statement, a question and one or more correct answers. The system can be configured to force the student to write a text answer in a free field or to choose between different predefined options where only one is correct. In addition, the teacher must also enter the incorrect alternatives. The teacher has the possibility to set up several sessions with different questions and invite different students to each of them.

The platform consists of 3 subsystems.

- **Administration subsystem.** Where the teachers can create their games, modify the parameters of the default configuration, and add questions to the content. It is also the system in charge of organizing the students in different game sessions. The interfaces and parameters of this module have been studied in detail so that teachers have the best possible user experience and are able to generate a game quickly and without errors during the process. The subsystem has been developed using the VueJs Framework and Firebase tools.
- **Game Client subsystem.** This consists of the video game prototype that has been designed. With a very simple graphic design of 2.5 dimensions, it is very light and interoperable in order to be used on low-powered computers and thus be available to the maximum number of students. This has been developed mainly in JavaScript to be used in a browser.
- **Server client subsystem.** This is in charge of synchronizing the video game between all the players and the platform data. In this way, the questions that have been configured during the game are included in the game. For this module, we have used technologies such as NodeJs on the server side, and WebSockets as a means to establish communication with the clients of the videogame.

IV. Use Case

This use case provides a comprehensive example of how the platform can be used. To begin, the teacher accesses the platform via the web and defines the parameters of the game they wish to create. They can then enter the players and modify default game settings as desired. Once this has been completed, the teacher includes questions (Fig.3) questions can be included in the editor or imported into different formats. The teacher invites players to join the game, and configures the minimum number of students required for the game to start. By following these steps, the teacher can seamlessly and efficiently create an engaging and interactive learning experience for their students.

Fig.3. Configuration view.

Each student will join the platform. They can select a session on the main page. At the start of the game, each player is transported to his own island and must wait his turn. Each island has a flag in the middle and a block generator. The turn information can be found at the top left of the screen, and in it shows the number of flags and the building blocks available for the player. In the player's turn he can move using the mouse, with the movement being limited to a maximum number of cells.

When the player moves to a cell adjacent to a block generator, he can retrieve the blocks stored in the generator. The generators create blocks at every turn. The collection of blocks is one of the actions that has associated questions. When collecting the blocks a dialogue box will appear for the player to answer the question (Fig.4). If the answer is correct, the player will receive twice as many blocks.

Players have to move to other islands, so initially they must collect blocks to build bridges to the other islands. The objective of moving to another island is to capture the rival flag. The construction of bridges is done in the same way as the movements, but instead of by land it is done by sea. When moving the mouse, the blocks will be discounted, and when clicking the mouse, the bridge will be built (Fig.5). The bridges can be used by all players, not only by the one who built them. These bridges have a finite duration and begin a process of destruction once built as they disappear after 5 turns.

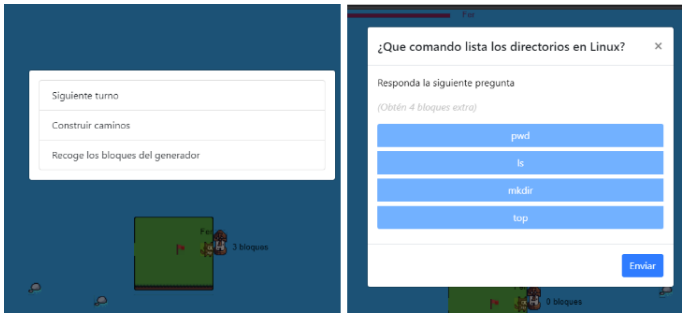

Fig.4. Player answering educational question.

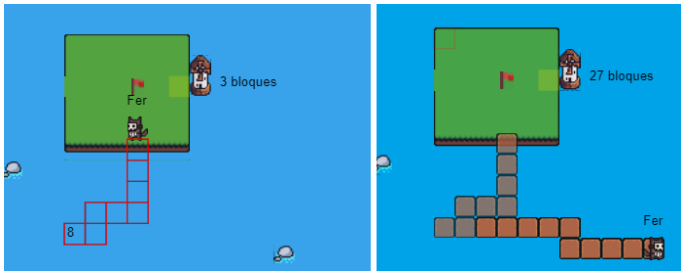

Fig.5. Player building a bridge.

Once a player gets an opponent's flag, he will carry it over (fig 6). At that point, he must carry the flag to his own island to get a point. Once the player delivers the rival flag to his island, the flag reappears in its original place, opening the possibility for it to be captured again by another player. The ranking indicates the number of flags retrieved by each player. The teacher can set a number of flags to obtain or simply let the students play for a period of time and see how many they get.

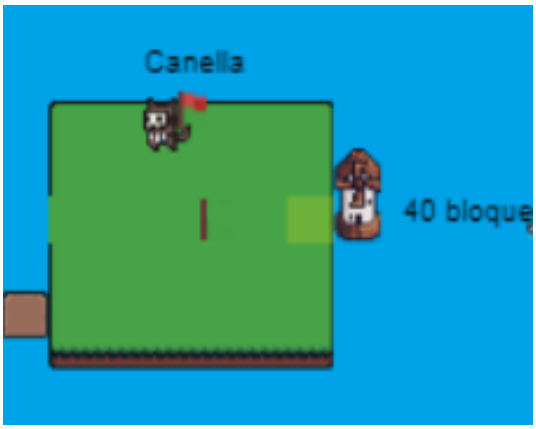

Fig.6. Player getting an enemy flag.

V. Evaluation

In order to validate the research goals, a three-phase evaluation process was carried out:

1. Evaluate the game creation process. Analyzing how long it takes to create a collaborative multiplayer game with the proposal and comparing it with current alternatives.
2. Evaluate the students' gaming interaction, focusing on new students who have never seen the game before to learn the mechanics quickly. On the test of the proposal carried out in the classroom, game logs have been obtained and the evolution in the number of actions performed by the students has been compared.
3. Impact on motivation. To evaluate the use of the output game and its impact on **motivation**, first, a comparison was made of the characteristics that potentially allow an increase in motivation, and the proposal was compared with the most popular alternative currently available. Secondly, the game was used in a real classroom and a survey was conducted asking students.

A. Game Creation Process

The incorporation of this type of video games in the classroom requires prior knowledge and effort on the part of the teacher. Therefore, in this evaluation we will try to estimate the amount of effort required by the teacher to prepare an activity with each of the alternatives. We set the objective of creating and sharing a simple multiplayer game which include a question and four options, which offers feedback to the student who answers the question.

In order to measure the complexity of creating this game, two evaluations were carried out - a first evaluation to measure the user's keyboard and mouse activity with the mousetron tool, and a second measurement based on the KLM-GOMS technique [28] to estimate the amount of time it takes an average user to interact to complete a specific task. All games have been created by an expert user who knew how to operate the tools. As no confusion or learning is being taken into account, this would be a near optimal iteration. This type of evaluation abstracts the human factor since the teacher's background can be very different.

The results show (Table I) how our proposal has a similar complexity to other alternatives just based in questions, and which are not real games. It is much simpler with respect to more complex platforms such as Minecraft or Roblox, which require **7.29** and **11.31** times the time needed in our prototype.

The evaluation based on the KLM-goms technique monitored five variables. The number of times a keyboard key was pressed (K). The number of times it was necessary to point to an object (P). The number of mouse clicks (B). The number of transitions made between the mouse and the keyboard (H). The number of times the user interface displayed an element on the screen that required extra mental preparation (M). The in-game action needed (G). Assigning each action a time in seconds of 0.20 (K), 1.10 (P), 0.10 (B), 0.40 (H), 1.20 (M) and 8.5 (G) respectively [28].

The times obtained with KML-Goms (Table II) show that Kahoot, Quizlet, Arcade Game Generator and our proposal are the most agile platforms, with times of around 25 seconds, Kahoot being the fastest with 20,8. Minecraft Edu obtained a time of 578 seconds, 154,2 seconds for Scratch and 805,8 seconds for Roblox. This points how the most flexible platforms when it comes to creating customized experiences also require a greater amount of work on the part of the user. The times measured with the KLM-goms procedure, are the times that the user interacts only with the user interface, while the Mousetron measures the total time of the task. That means that KLM-goms skip the loading times of each platform.

B. Students' Gaming Interaction

In order to determine the degree to which the game is easy to learn, the actions performed by the students in the test scenario have been recorded. The following graph (Fig.7) shows the evolution of a 13-players game and the number of actions the students performed in each minute. The starting point was a game designed with questions about operating systems. The students played the game. As the game has a maximum game size of 12 players, they were randomly divided into 2, playing exactly the same game. The actions recorded do not include the movements.

The test performed had turns of 20 seconds, this time being extended when a student receives a question. In each turn, the students perform

TABLE I. MOUSETRON METRICS

	Time (s)	Mouse movement	Key strokes	Mouse left button	Mouse right button	Double click	Wheel
Proposal Game	**86**	190.5	118	21	0	0	0
Kahoot	89	358.14	63	19	0	1	10
Quizlet	76	388.62	75	15	1	0	33
Arcade Game Generator	72	198.25	79	13	0	0	0
Minecraft EDU	627	1780.54	384	130	53	11	128
Scratch	235	2034.54	105	116	3	22	182
Roblox	973	16312.51	642	498	41	16	441

TABLE II. KLM-GOMS METRICS

	k	p	b	h	m	g	Total (s)
Proposal	**27**	7	5	3	9	0	25,6
Kahoot	26	4	4	3	8	0	20,8
Quizlet	27	6	4	3	8	0	23,2
Arcade Game Generator	32	6	5	4	9	0	25.9
Minecraft EDU	29	11	14	7	17	63	578
Scratch	52	17	20	11	21	11	154,2
Roblox	82	43	32	18	36	81	805,8

a movement and an action. When they finish the action, the turn ends. If no action is performed, the turn ends automatically after 20 seconds. The graph shows how, as the session progresses, the number of actions per second increases. It reaches up to 19 actions per minute. In the 22-minute period that the game lasted, an evolution in the speed of the game can be observed.

At the beginning of the test, values are below 5 actions. Turns were running out for some players. This is due to the fact that it was the first time that the students used the game, and they did not know the controls and mechanics of the game well, despite having been briefly explained at the beginning of the test. When the number of actions per minute exceeds 6, it means that all 6 players have been able to perform their action in one minute, which means that each player takes about 10 seconds, half the preset time in one turn. When the number of actions exceeded 12 the number of actions was quite fast indicating that they already had a very high level of understanding of the game.

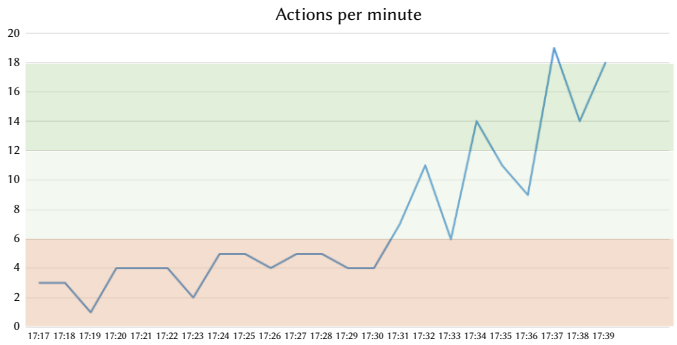

Fig.7. Actions from students per minute.

C. Impact on Motivation

To evaluate the use of the output game and its impact on motivation, first, a comparison was made of the characteristics that potentially allow an increase in motivation, and the proposal was compared with the most popular alternative currently available. At the designing of the game a series of characteristics were identified that were estimated to positively influence game motivation. We point out that the mere fact of including these features does not mean that the level of motivation is necessarily higher. We analyzed which of these features could be fulfilled by the proposal and other alternatives. Fig. 8 shows the results.

Generated game complies with 6 of the 8 characteristics evaluated. It needs an internet connection and a web browser. One of the most popular solutions, Kahoot, complies with only 3 features. Minecraft EDU and Roblox, could meet all the features depending on the implementation of the game by the teacher. It should be noted that both options require the installation of a client application. Popular platforms such as Scratch can be used to create video games in educational environments, but these video games cannot have synchronization between players as they are mainly designed for a single player. On the other hand, we find platforms such as Arcade Game that could only meet two of the evaluated characteristics.

The seven tools analyzed could be used to create game dynamics with subject content. The degree of customization that can be achieved with each tool varies, although greater customization requires a deeper knowledge of the platform or knowledge of programming concepts. Our proposal and tools such as Kahoot, Quizlet or Arcade Game generator offer very limited actions. Teachers must configure some values and introduce the subject information. On the other hand, Minecraft, Roblox and Scratch are game creation platforms that have different modalities and even make use of development tools, which require a higher level of knowledge.

Secondly, the game was used in a real classroom and a survey was conducted asking students. The solution was evaluated in a class with 13 students from a vocational training center, taking the subject of operating systems. Of which 77% were men, and 23% were women. 85% percent of the students acknowledged playing video games on a regular basis.

Eighty-six questions were prepared with four possible answers. Each question had only one correct option. These questions have two types of design, a first design where a statement is exposed, in which a word is missing, and students must complete the sentence, and another type where a question is directly posed and the correct answer must be chosen.

They are used to using Kahoot in their classes and they know how it works. They have also recently used Kahoot in a class. This is relevant because we are going to ask them in the survey if they would like to use the proposal or Kahoot more. Kahoot works like a trivia game where a question is presented to all students at the same time and they have a time limit to answer. If students answer the question correctly, they will get points. The faster they answer the question correctly, the more points the students get. After each question, they are shown a ranking of the students' scores.

The proposed solution was used during a class session. Initially, the basic functioning of the game was explained to the students for 10 minutes. The students were divided into two groups of 7 and 6 students. Each of the groups played in one server. We use this because there is a limit of 12 players per map, and both groups played exactly the same game. They played a total of two games for a total of 25 minutes.

Once the game session was over, a survey was carried out with a series of questions to analyze the impression they had had during the session.

- **Q1** *Do you think that thanks to the game, your level of motivation has been higher than other classes?*

  Students could choose between the options "much lower, lower, higher, much higher". In this case, 46.2% of the students answered that the experience with respect to other classes had been "Much higher, " 46.2% answered "Higher" and only 7.7% "much lower".

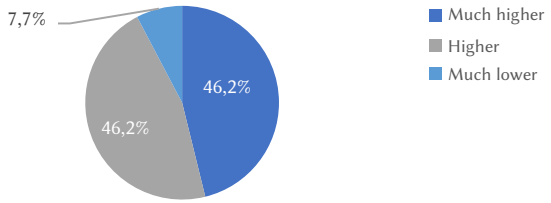

Fig.8. Responses percentage.

On the other hand, we compared the experience using Kahoot, with our proposal that integrates questions within a competitive video game. For this purpose, the following question was posed:

- **Q2** *What type of game do you prefer?*
  A. "A game of only questions based on classroom content (Kahoot type)."
  B. A multiplayer video game in which answering questions can provide some competitive advantage in the game (video game used in the session)

  On this question, **92.3%** of the students chose the second option. This showed that their experience had been more positive.

  We were also interested to know if the students preferred to do these types of review activities together with their classmates creating a dynamic of competition, or if they preferred to do a similar activity individually. In order to know their opinion, we asked them the following question.

- **Q3** *To what degree do you consider that doing these types of review exercises together with your peers is more satisfying than doing them individually?*

  They could answer by choosing from a range of 1 to 5, with 1 being "Less satisfactory" and 5 being "More satisfactory". The average obtained in the students' answers was 4.46 with a deviation of 0.78.

In order to find out to what degree they had found the experience positive and believe that it would be useful to transfer these types of activities to other subjects, they were asked:

- **Q4** *Would you recommend using this game to other teachers?*

  They were able to choose on a scale of 1 to 5 both included. The lowest score means that they would not recommend it and a 5 means that they would. The responses obtained an average of 4.46 and a standard deviation of 0.88.

Finally, they were also given the opportunity to make some comments about their experience with the game. And how they think it affected their motivation or how useful they think it can be in their learning process. Some comments highlight the usefulness of the application to set concepts or memorize concepts that they needed for the subject. They also pointed out how positive it had been for them to carry out this type of activity after several hours of class.

VI. Conclusions and Future Work

In this research work, we focused on providing an innovative solution that enhances the user experience of teachers when creating multiplayer educational games. We observed that most common educational games, like Kahoot, lack real game mechanics and mainly consist of questions with some gamification features. On the other hand, real multiplayer games, such as Minecraft EDU, require a significant amount of work from teachers to define and configure the game's parameters.

Our proposal allows teachers to create multiplayer cooperative video games with real video game features without the need for extensive configuration. Based on our evaluation, teachers can easily configure their game and teaching content. In comparison to other tools such as Kahoot or Quizlet, our proposal's complexity is similar, with a minimal difference of only 3 seconds in time required for usage. Furthermore, our proposal significantly outperforms other alternatives such as Minecraft EDU or Roblox, which require up to 700% more time for configuration.

The games generated through our proposals feature user-friendly video game mechanics that are easy for students to understand and control. To evaluate this objective, we measured the number of actions performed by students who tested the game. Results showed that within approximately 14 minutes, students were able to play the video game smoothly at an expert player's level.

Additionally, we assessed student motivation compared to the reference Gamification tool Kahoot by distributing questionnaires to the students participating in the test. The response to the proposed solution was overwhelmingly positive, with 92.3% of students preferring it over tools based on questions, such as Kahoot. Furthermore, 46.2% of students reported in the survey that thanks to the game, the level of motivation was much higher than in other classes.

Students were highly satisfied with the opportunity to work collaboratively on questions (4.46/5) and most recommended the use of the proposal in other subjects (4.46/5). Overall, the proposal's impact on motivation and engagement in the classroom was remarkable, and it was well received by students as a valuable and exciting tool for learning.

Overall, our innovative solution offers a streamlined and efficient process for teachers to create multiplayer educational games with real game mechanics and engaging features, ultimately enhancing the learning experience for students.

As future work, we are considering the possibility of looking for systems that automate the generation of questions or content that can be implemented in this type of video games. For the preparation of the sessions, extra work has been required by the teachers to prepare the questions and configure the activity within the platform. Therefore, we are interested in evaluating whether the use of this type of tools achieves greater acceptance by the teachers, without losing quality of the learning content.

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