Education, Language and Sociology Research
ISSN 2690-3644 (Print) ISSN 2690-3652 (Online)
Vol. 4, No. 3, 2023
www.scholink.org/ojs/index.php/elsr

Original Paper

Participative Production of Students in the Development of Math Video Games at Higher Level Education

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Received: May 16, 2023 Accepted: June 9, 2023 Online Published: June 24, 2023

doi:10.22158/elsr.v4n3p14 URL: http://dx.doi.org/10.22158/elsr.v4n3p14

Abstract

This paper shows how, through a participative production of student's community of the Metropolitan Polytechnic University of Hidalgo in Mexico, it is possible to improve the academic performance of new students in the propedeutic course of mathematics. The production consists of the design, development and application of an educational video game focused on mathematics, specifically algebra. As a result of the participation of students, there is a larger identification and a sense of belonging to their engineering. This is a benefit for students who aspire to be admitted in the Engineering of Animation and Visual Effects because, in addition to receiving feedback about the topics that are learnt in class, they can observe digital scenes and 3D animations that they will be able to create during their university studies.

Keywords

Algebra, higher education, learning tools, participative production, videogames

1. Introduction

In today's society, the use of innovative technologies has covered practically all areas of everyday life. In the education sector, new technological methods and tools have appeared which use is growing exponentially in schools. Applications based on information and communication technologies (ICT) provide many options, so educational institutions are creating competitive advantages for themselves through the alternatives they offer to students, such as choosing what and where to learn (Oliver, 2003; Sánchez & Ursini, 2010). The use of ICT is also closely linked to the development of skills such as: creativity, logical reasoning, critical thinking, problem solving, decision making, networking, etc. (Ivanova, 2016). That is the reason of its importance in education as a tool that allows the teacher to better provide learning and knowledge to students, who are immersed in a new environment with

potential means and resources to improve (Colom et al., 1988). It is possible to say that any ICT can become a means of teaching if it meets or helps to meet the learning objectives.

In schools, students perform tasks and practices on computers, and sometimes on smartphones, as part of their learning process. However, at home they prefer to do other activities with electronic devices that they have, for example, play video games. Although they are not well seen by many parents and teachers, video games go hand in hand with the new technologies that teenagers are strongly adopting, at the same time that their commercial popularity begins to transpose in several of the daily activities (Annetta, 2008). But there are factors that prevent the majority adoption of ICT in education, including lack of support, training and motivation (Torrente et al., 2008). Therefore, it is essential to develop new techniques that attract students' attention and at the same time provide them with school knowledge. Also, students should feel identified with the medium or product they are using to achieve greater interaction and understanding,

As users or consumers, students only accept or reject the final product. But beyond this they have no major influence or decision power, so they see the product as something distant and do not feel any loyalty towards it. However, when students belong to the same community, they share a bond based on common characteristics and interests. They are no longer only considered as users or consumers of the product, but they intervene in its configuration, actively contribute to its creation and help to delineate the form it will take in the different stages of its development until the end. Since a community is not a separate entity that will only consume the product, but is co-creator, it will always embrace the end result and feel loyal to it. This represents a clear advantage over products or works focused on some platform and that see the audience only as final consumers.

At the *Metropolitan Polytechnic University of Hidalgo* (UPMH), since 2017 a math propedeutic course has been implemented to try to level the knowledge of new students according to the requirements of higher education. Historically, this area has been complex for most teenagers in the country, so the university continually starts extracurricular courses. However, despite the great effort that is made, the results have not been as expected. Three years after the beginning, about 20% of students fail the course, especially in those careers where mathematics is not essential, although necessary, as is the educational program of *Engineering in Animation and Visual Effects* (IAEV).

For this reason, this research is aimed at the participatory production by IAEV students for the design, development and application of an educational videogame that helps the teaching-learning process within the math course to enter the educational program. This is intended to reduce the failure rate and make new students feel identified with engineering from the beginning, since the video game offers feedback on the topics seen in class and at the same time enjoys virtual environments that students will be able to create at some point in the career. The development of these new learning models complements the traditional ones, highlighting that they are ICT that most teenagers like.

2. Mathematics Propedeutic Course

UPMH is a public university located in the metropolitan area of Pachuca, Mexico. Its purpose is to provide higher education in the levels of bachelor's degree, engineering, technological specialization and other postgraduate studies, as well as updating courses in its various modalities, to prepare professionals with a solid scientific, technological training and in civic and ethical values, aware of the national context in the economic, political and social (www.upmetropolitana.edu.mx). Achieving the aforementioned purpose requires the redesign of learning situations through new didactic strategies, since the new profile of students requires the development of a series of skills where not only knowledge is acquired for problem solving, but also useful skills in everyday and specific contexts of each profession (Rodríguez Gallegos, 2016). The university teaches special courses for the development of skills that contribute to the training of students.

One of these courses is the math propedeutic, which is a requirement for students to enter any educational program. The purpose of the course is for new students to have the same basic knowledge, since the subjects related to mathematics are those with the highest failure rate. In the IAEV educational program, mathematics-based subjects are part of the common trunk curriculum, so all students must accredit them. For this career, the propedeutic course covers topics of arithmetic and algebra, since subjects such as linear algebra and vector calculus reached reprobation rates close to 40% before the course was implemented. However, after three years of starting the procedure (September 2017 - August 2020), the results were not as expected, since 30% of the students still failed the subjects mentioned. And worse, about 20% of the students did not pass the propedeutic course, showing that they did not have at least the knowledge of the upper middle level.

For this reason, the IAEV Academic Body considered the need to redesign the course through methodologies and didactic techniques that were pleasing and functional for its students. The measures were based on the reformulation of teaching through various educational video games developed by professors and students of the career based on their experiences in the course. This is intended to reduce the failure rate and prevent students from dropping out.

3. Educational Video Games

From the use of interactive whiteboards, educational videos, virtual platforms, mobile applications and much more, the use of ICT is increasing. One of the media with the greatest future is the use of video games and virtual environments. The most important use of video games in classrooms consists in those that are designed and developed, from the beginning, to have an educational component. In these cases, the game is designed to teach a specific educational content and it is introduced to encourage student motivation. Educational video games allow complementing, and sometimes replacing, more traditional resources. Gros (2009) mentions that these video games "aim to use the advantages they provide, but their fundamental objective is not entertainment but learning." Likewise, Durall (2009) adds that "they have the objective of creating bridges between the recreational and the real world and for this reason they

have been used as a means for education, learning new concepts, awareness, social or political denunciation and even propaganda, marketing and advertising."

The use of educational video games is an attractive and motivating element for the school population, since learning is implicit through hidden concepts in challenges and activities, as well as the application of collaborative learning techniques that allow students to develop their social skills while learning (Padilla et al., 2012). For this reason, learning based on ICTs, through fun and group tasks, should be considered within the educational classrooms, acquiring curricular skills, developing a research thinking, socializing the experiences, that is, experiencing different models, methodologies and educational experiences according to the possibilities they offer (Cabero & Aguaded, 2014). In addition, they are highly interactive compared to traditional activities and can be a powerful source of data for all forms of evaluation (Serrano-Laguna et al., 2014).

As strong means of a technological-digital nature, the use of videogames can produce two types of benefits: the socio-affective dimension of the dynamization of group relationships and collective work based on reflection on content that materializes in applicable behaviors and values to everyday behaviors and, their contribution to the development of skills and abilities such as eye-manual coordination, the development of spatiality, psychomotor control, problem solving, imagination development, thinking, memory and treatment of information, (Aguilar & Farray, 2003). Working with interactive tools can mean a better understanding of students of concepts of difficult traditional explanation. Video games increase the motivation for learning various subjects, so their use in schools responds to a need for use, since most students perform this activity on a regular basis (Morales, 2009).

4. Participative Process

Normally, a video game production with high quality standards, however small, is a complex, expensive, difficult process that involves a lot of work time. It is common that video game creators to be unable to produce their creations due to economic constraints and lack of technical or human equipment. Sometimes, after an arduous effort the creator faces the difficulty of getting his work to the public, or that their work is not accepted by the audience despite all the work, money and time spent. Given this situation, in recent years new production models have emerged that radically change the traditional way of approaching the creation of video games, applications and new media. If the creator normally cared about the platform he would use for his work (console, cell phone, computer, etc.) and his target market, now the creator focuses on the community for which the work is intended.

The current production paradigms propose to implement the participation of the community in the production processes existing in its environment (Rolnik, 2009). This measure seeks to guarantee the viability, legitimacy and applicability of proposals that do not depend exclusively on the technical sector, but assume the population as the main recipient and executor of the actions related to production. However, the task of carrying out participatory processes is complex and sometimes unfeasible, since the community and technicians have naturalized a unidirectional production model, characterized by social

and urban fragmentation, which in most cases do not take into account the needs of the majority of the population (Boldrini, 2015). In this sense, Harvey (2007) states that production, in any field, requires an imaginative exercise, the mobilization of desires and actions to respond to needs. However, he affirms that this process is denied to most of society in industrial capitalism, establishing and naturalizing a deeply alienating situation, so many times community participation is not total.

The first element to highlight is that a "process" is not an exclusive moment but a succession of moments or actions. The second element is the adjective "participatory", which assumes that different people take part, debate and propose. That is, when talking about a "participatory process" it refers to a sum of participatory moments and actions (workshops, group dynamics, meetings, interactive exhibitions, virtual forums or work groups, creative shows, etc.) related to the participation of different representative people to provide different perspectives or visions in relation to an issue on which a decision is to be made (EUDEL, 2008). The reality is that participation is not a fixed state, it is a process through which people can gain more or less degrees of development intervention. What really determines people's participation is the degree of decision they have in the process. Success will depend, among other things, on the organization of the people themselves, the flexibility of the institution, and the availability of all actors (Geilfus, 2002). It is evident to underline the decisive role of the public in the reconfiguration of all aspects of cultural consumption (Roig, 2011).

However, it is also true that every process generates uncertainty, has unpredictable moments, does not progress linearly, nor does it always have the same actors and actresses. Therefore, in order to manage the processes, it cannot be pretended that there are regulations or norms that are capable of collecting all the casuistry and giving a standardized response for situations that have not been foreseen. It is for this reason that, in order to promote and manage processes, methodologies are needed more than standards, understanding the methodology as the set of strategies capable of developing and implementing the unforeseeable situations. The strategies do not give sure answers, but they point out ways to follow and allow the participatory process to be redesigned flexibly according to how it is progressing (EUDEL, 2008).

5. Video Game Development

As in all audiovisual production, the production staff made a proposal of steps to create the video game and present a good story. Therefore, a diagram was established with the stages to follow for the realization of the video game. The only thing clear is that algebraic issues should be addressed for new students. The key to achieving a good video game is to find a balance between script and gameplay. Normally the gameplay is the essence of the medium, since no matter how good a game is, it is very difficult for a person to finish it if the mechanics of the game itself is bad. The suggested elements to create the script were:

- Choose genre
- Create a character

- Create the story
- Merge story with gameplay

Having these steps to follow was important, since the script had to mix classic elements of the narrative, such as the characters, the narrator or the dialogues; with elements of the contests, such as the challenge, the competition, or the puzzles to solve. At a structural level, as video games are not usually linear like a movie, they usually work with trees that fork as the players make their own decisions. So, each branch should be developed, thinking about the characters, what they should do, in what location and what the gameplay will be. Finally, it was proposed to have meetings with students to determine the viability of the video game.

5.1 Session I: Script

The first group work session was held with senior students, as they have more knowledge and provide better opinions on screenwriting. In the session they were explained what the project consisted of and after answering a brief questionnaire with questions such as: Do you like the idea of the video game?, Do you think it helps the students of the propedeutic?, and Would you use entertainment to learn Mathematics?, the viability of production was determined. The next thing was to try to establish the script and therefore the gameplay. For this, the points of the initial proposal were discussed:

- Choose genre: being the first point to be treated, students showed apathy and accepted all the proposals of the teachers. But as time went by, students changed their position and gave several recommendations about the video game. First, it must be in the third person so that the player identifies with the character and endorses the story. Then, a genre of platforms where the player must overcome obstacles, defeat enemies and collect objects:

  Teacher: We agree that it must be fully educational (video game), since the purpose is for students to learn mathematics.

  Student 1: I think genre should be rethought. As such, mathematics is tedious. If you only put numbers, it will be boring for everyone.

  Student 2: It should be a platform game, with challenges and prizes.

  Student 3: Sure, a good story with challenges, whoever solves it faster earns more points.

  Student 1: The challenges could be mathematical applications, which are not simple operations, but as they apply in daily life.

- Create a character: the main proposal was to illustrate a character with notable contributions in mathematics. The character on the cover of Algebra's book whose author is A. Baldor came to mind. In the end it was decided to open a call for participants to make their designs with that character or any other that met the conditions. The next session was given to define the character.
- Create the story: everyone agreed that the story of the game should be divided into levels or missions that the player had to solve until its end. The challenge now was to develop a good story, since the more the player identifies with the story and the need to solve the challenge, the more addictive the game will be.

- Merge history with gameplay: it was not possible to determine it because the game mechanics cannot be traced without a story. It was generally defined that the game would be in the third person and that the character would have freedom of movement. In addition, it was considered to set a time limit, set a score, have several opportunities to solve a problem, and establish help clues.

The above without forgetting the purpose of the video game, so it was proposed to work with expert teachers in mathematics to create a product that is a learning tool. It was also agreed to create social networks to place the progress of the project and anyone could give their opinion.

5.2 Session II: Character

The social networks implemented were a success, they managed to make a large part of the university community belonging to IAEV aware of the project. This was reflected in a considerable number of messages on the blog of the website, the attendance of students of all grades to the sessions, as well as in a large participation to choose the character of the video game. 46 proposals were received, of which most were related to *Al-Juarismi* from the book *Algebra*. Others were starring *Carl Friedrich Gauss*, who is considered the prince of mathematics. A third prominent option was *Hypatia of Alexandria*, who is the first known mathematician woman. There were more proposals such as: *Pythagoras of Samos*, Isaac *Newton*, *Alan Turing* or *Leonhard Euler*, but they did not transcend. After reviewing the designs and reading the biography of each of the mathematicians, the pros and cons were stated. The relevant thing arose when talking about *Hypatia*, since the women present considered her the best option:

Professor: Now we will talk about *Hypatia*.

Student 1: She would be fine, Animation (IAEV) is an engineering with many women studying it, a game with a female character would attract more attention.

Student 2: Women play less. With her they would feel identified.

Student 1: Although she didn't contribute much like *Gauss* or others, being the first mathematician in history says a lot about her.

Student 3: In this era of gender equity a woman as the main character is suitable.

Student 4: It is part of learning. Those who play will know who *Hypatia* is, the other characters are already known or will be recognized for their theorems.

Student 5: There's even a movie about her: *Agora*.

The arguments given by the students changed the public's perspective, accepting that *Hypatia* has many favorable aspects. At the end, the vote was taken to choose the character, the vast majority voted for *Hypatia of Alexandria* and specifically for a sketch that portrayed her perfectly according to the existing photos. For the production of the character, activities such as modeling, UV mapping, texturing, rigging, animation and state machine are contemplated, using specialized software such as *Maya*, *ZBrush*, *Photoshop* and *Blender*. Figure 1 illustrates the sketch and production of the character that took three weeks to complete. The next thing was to define the story of the video game. Teams were formed to write proposals and in the next session they would choose the best one, in addition to looking for math teachers to analyze topics and algebraic exercises.

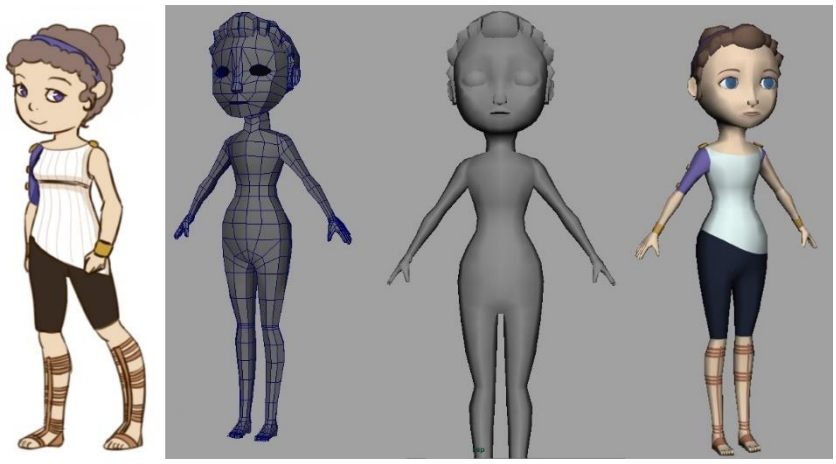

Figure 1. Main Character

5.3 Session III: Mathematic Content

The session was destined to the work in the game's story, but it was possible to contact and take expert teachers in mathematics, so that was the central theme. In addition, first grade students were cited to share their experiences and mention the issues that were most difficult for them when they took the propedeutic course. Although the course syllabus is broad, most of the students agreed on the fundamental topics:

Student 1: Algebra is the basis of everything. Until I learned to isolate, I could solve more difficult problems.

Student 2: Not only isolating, also operations with polynomials.

Student 3: And factoring... I don't remember the formulas (theorems). It would be good to put them in the game in the form of messages.

Student 1: Knowing how to isolate and operations (polynomials) is enough. The other themes are based on them.

Student 4: Yes. The syllabus includes linear equations of one or more unknowns and quadratic equations. But the above is the basis.

Student 3: But the game must include them. It should go from the easiest to the most difficult.

Teacher: The basics are (algebraic) expressions. After the operations.

Student 3: Then the linear equations with unknowns and finally the quadratic equations.

According to the curriculum of the propedeutic course and the comments of the students, the teachers divided the content into six areas: algebraic expressions, algebraic operations, notable products and factoring, first degree equations, systems of equations, and second-degree equations.

5.4 Session IV: Story

Much of the story was determined in social networks in advance, as the various teams reached an agreement on the course that the game should take. Participants agreed to create six stages and each of them would cover an algebraic theme. In particular, the stages would be cities worldwide where important

contributions to mathematics have occurred. The character had to travel to each city to solve the challenges and level up. In addition, pieces had to be collected so that in the end the mathematical symbol of infinity could be constructed.

During the session, the first thing was to establish the cities. It was determined that Mexico City should be one of them, although it does not have many contributions to the field. The list of cities and their relationship with the mathematical content is:

- Level 1: Algebraic expressions - Cairo, Egypt.
- Level 2: Algebraic operations - Paris, France.
- Level 3: Notable products and factoring - Moscow, Russia.
- Level 4: First degree equations - Tokyo, Japan.
- Level 5: Systems of equations - New York, United States of America.
- Level 6: Second degree equations - Mexico City, Mexico.

A student proposed an evil character to be added to the story, as every video game has, in order to make it more attractive. This generated controversy since other students argued that the purpose of the videogame is didactic, so it is not necessary to have an antagonistic character:

Student 1: Don't you think an evil character is necessary?

Teacher: It's an educational game. With getting a reward at the end I think that is enough.

Student 2: An evil character can divert attention from the game.

Student 1: And is not part of the purpose? Play and learn at the same time perhaps without realizing it?

Student 3: In every game there is an antagonistic.

Student 1: It could be added, but not like to fight him. But to distract the character. The one who laughs when we're wrong.

Student 3: It would make it more attractive. And along with time there would be two obstacles to overcome.

In the end it was decided to add antagonistic characters, one for each level. Their purpose is merely to distract the user and press it to end on time, at the end of the level, the character disappears. With this, the story was established as follows: in Mexico City there is a sculpture of the infinite mathematical symbol, which is destroyed by antagonistic characters, who take the pieces to different places, the main character must go to these places to recover the pieces, which is achieved by solving algebraic problems in a timely manner. All this is presented in an animated intro. The next thing to do was to specify the gameplay, for this, teams were defined again with the intention of generating proposals.

5.5 Session V: Gameplay

Again, students agreed on some points in advance through the website and social networks. They also visited math teachers to establish possible exercises and adapt them to each level. Among the agreements reached, it is worth highlighting that the exercises will be dispersed throughout the stage and the user will have to find them to solve them. In addition, clues of how to solve the exercise will be included, as

well as trophies to those who finish them faster and make fewer mistakes in order to improve their final score. Obviously, there will be a time limit to solve each exercise and finish each level, but this will depend on its complexity. In each level there will be between 5 and 10 exercises to be solved according to the established time, and they will be obtained randomly from a combo of at least 30 exercises, so they will hardly be the same if a person plays several times.

The session focused on trying to adapt the mathematical content, history and gameplay with the levels of the video game. The first thing was to create scenes based on the proposed cities, which would not follow the original layout of the place, but would include its main monuments and characteristics, so that the user could quickly identify each location. Afterwards, the different teams went on to expose their game form, in total there were 4 proposals for each level. One by one the best one was chosen according to the opinions of the students and teachers. A brief description of each level is:

- Level 1: The stage represents the *Valley of the Kings*, where the tomb of *Tutankhamen* and the *Pyramid Complex of Giza* are located. The objective is to collect ancient objects that have letters or numbers to form the algebraic terms that are requested in temples and pyramids.
- Level 2: The tour begins at the *Eiffel Tower* and ends at the *Arc de Triomphe*, including the *Champs Elysees* and the *Louvre Museum*. It is necessary to solve the operations of polynomials written on the lamps. This is done by spheres of light that fall slowly, each one with algebraic terms.
- Level 3: It is located in the Red *Square*, with various buildings such as the *St. Basil's Cathedral* and the *Kremlin*. The player must find the treasure chests that are scattered. These chests contain an equation and open only if the notable products or factoring is successful.
- Level 4: It is an environment of the *Shibuya* neighborhood, a modern shopping and entertainment district. The mission is to walk through the food stalls and stores to buy requested accessories. The price payable is obtained by solving a first-degree equation.
- Level 5: The framework is located in the streets of New York City, with the *Statue of Liberty* and *Central Park*. The purpose is to visit different places and solve problems of systems of equations about the number of animals in the zoo, souvenirs in the store, taxis in the street, etc.
- Level 6: It is located in the *Zocalo* of Mexico City with the *Palace of Fine Arts*, the Angel of *Independence* and a part of *Teotihuacán*. The task is to climb the pyramids and palaces to find hieroglyphs of second-degree equations and solve them using the general quadratic formula.

All this was reflected in various storyboards that students made in days after the session.

5.6 Session VI: Production of Virtual Stages

The storyboards were reviewed jointly between teachers and students on several occasions so that they were ready in this session, in which teams were formed to make all the 3D models and virtual stages of the 6 levels of the video game. Each team was formed by approximately 20 students of all grades. Due to the high participation, particular activities were defined for each of them with the purpose of shortening production times, since it is a very slow and detailed process. The complicated thing came at the end of the session, since it was very difficult for all students to work at the same pace. This is because at the

same time they had to fulfill their academic, sports and even work activities. Having as consequence that some students did not begin with the task assigned because they depended on the work of other people. Likewise, as there was a diversity of degrees and knowledge in the students, some had difficulties to perform their tasks, so other students had to provide help, which was reflected in a slow progress in the production of the stages and pessimism in great part of the participants:

Student 1: Hey teacher, the fifth-grade students are very late with the models.

Professor: How many have they made?

Student 1: For Russia they are about 40 and they have barely completed 10. I think we should get more people. We are already helping them.

Professor: They tell me that they have had a lot of homework in their subjects.

Student 1: It will take us a long time; without the models we cannot move forward.

Student 2: Modeling may be a slow process; I think we should all help them or we will not finish.

Student 1: Several students are already realizing how difficult it will be. Let's hope they don't quit.

Professor: Let me talk to them. There were many people who wanted to participate.

Derived from the above, 5 more students were added to each team to try to finish according to what was established. The stipulated time to complete this part was 8 weeks, however, it took 12 weeks to have all the stages. Once all the digital models have been created, they are exported to the virtual environment developed in the *Unity* software, where all the development of the city is carried out according to the storyboard. Also, the programming of the character and some objects is made so that they have the ability to move. In addition, background music and sounds are introduced for certain elements such as jumps, steps, strokes, etc. Figure 2 contains images of the 6 levels. Despite the long time it took to finish this activity, the results were positive, since high quality was achieved in the virtual models and stages.

Figure 2. Virtual Stages

5.7 Session VII: Testing

After a hard work in the development of the videogame, the last session was reached, which consisted of several students performing tests to verify its operation. It is clear that several errors were found, among which some stand out: the character went through objects, the texts could not be read, textures were poorly placed, the successes in the exercises were not listed, among others. Fortunately, they were solved satisfactorily in the following days. Once this was done, the Beta version of the videogame was made, which means that it is practically finished, so it can be used on a desktop or laptop computer. For students, designing and developing a video game was a challenge, but when they tried the video game they had created, they were impressed. Leaving aside the problems in the operation of the game, the comments were favorable no matter to what grade they belonged to:

Student 1: I didn't think we were able to do it. It looks great.

Student 2: The graphics look real. It's not a Grand Theft Auto, but I would buy it.

Student 3: The gameplay is excellent; it entertains you at all times.

Student 4: The character moves well, almost like a person.

Student 5: It was a good job of all areas. We should make a living of this.

6. Video Game's Application

As in any project, the measurement and evaluation processes seek to identify the effects, impacts and efficiency of the product. If it is not measured and evaluated, there is no feedback and the results are not known nor weaknesses and strengths identified. To demonstrate the efficiency of the video game, it was considered as part of the evaluation of the second part of the September - December 2020 propedeutic course. In total there were 4 groups, but it was decided to start the application with only two. Most of the students mentioned that they had never played an educational videogame, only mobile applications that described step by step how to develop a specific process.

The teacher of the course considered it important for students to apply a brief written test before and after using the video game, in order to measure how good the feedback is. The exam consisted of 5 exercises similar to those presented in the video game. The results were not favorable. From a total of 58 students divided into 2 groups (A and B): 4 had 5 correct answers, 9 had 4 correct answers, 20 had 3 correct answers, 15 had 2 correct answers, 7 had 1 correct answer, and 3 had no correct answers at all. The goal was for students to improve their scores after using the video game.

Like every first time, the beginning of the game was slow and doubtful for the students. But after a while, they improved and got used to the gameplay. Students used the video game for approximately 1 hour, as seen in Figure 3. It should be noted that almost 95% of the students (55 of 58) were able to complete a level of the game on time.

Figure 3. Application's Use

The students left the classroom talking about the video game and commenting on how they solved a certain operation, which means that the game generated interest. Some of the comments at the end of the game were:

Student 1: It was a fun video game and it helps to reinforce the knowledge I already have.

Student 2: The game was difficult but good.

Student 3: I didn't remember how to solve the exercises, but I saw the clues and I could complete the level.

Student 4: With this way of learning I would go to classes daily.

Student 5: I really liked the scenery and the gameplay.

Minutes later, students returned to the classroom to solve another version of the exam. They felt more confident than they did before and that was reflected in the favorable results, since: 9 had 5 correct answers, 18 had 4 correct answers, 21 had 3 correct answers, 8 had 2 correct answers, 2 had 1 correct answer, and 0 had no correct answers. Looking at the results, it is remarkable that the video game helped students review the topics seen in class and increase their knowledge. Days later, the same process was applied to the two remaining groups of the propedeutic (C and D), obtaining similar results. Table 1 contains the complete information of the tests performed on the 4 propedeutic groups.

Table 1. Test Results before and after the Video Game

Group	First Test						Total
	0 ca	1 ca	2 ca	3 ca	4 ca	5 ca	
A	0	4	5	11	5	3	28
B	3	3	10	9	4	1	30
C	1	2	7	13	7	2	32
D	0	3	6	10	7	2	28
Total	4	12	28	43	23	8	118
%	3.38	10.16	23.72	36.44	19.49	6.77	100

Group	Second Test						Total
	0 ca	1 ca	2 ca	3 ca	4 ca	5 ca	
A	0	1	2	10	9	6	28
B	0	1	6	11	9	3	30
C	0	0	3	14	11	4	32
D	0	1	2	10	10	5	28
Total	0	3	13	45	39	18	118
%	0	2.54	11.01	38.13	33.05	15.25	100

ca: correct answer

The video game was still used for the rest of the course and complemented the evaluation of the global exam. In the end the improvement was evident, since close to 90% of the students passed the propedeutic. The teachers in turn highlighted that the video game changed the students' perspective about mathematics, given the fact that before the game, they considered mathematics complicated and boring, but after playing the game, they found them enjoyable and entertaining, which translated into a better understanding and greater learning. In addition, by belonging to IAEV they appreciated the work of their peers and were motivated to continue with their studies. The methodological strategy implemented during the development of the videogame complies with attracting students to obtain feedback on their knowledge and skills, in addition to increasing their interest and developing thinking processes, breaking the stereotype that mathematics cannot be taught in a fun way.

Due to the good results, the way of using the videogame was projected as an additional educational resource in the propedeutic course. The plan is that teachers use it at the end of each topic and be part of their evaluation. Table II shows the percentages of success and failure in various academic periods. It should be noted that, in the subjects of the area of mathematics belonging to the curriculum of the career, the failure rate decreased to 15% in the groups that previously used the video game, which was a significant advance.

Table 2. Comparison between among Different Academic Periods

Academic period	New students to IAEV	% Approved students	% Failed students
Sep-Dec 2017	88	73.86	26.13
May-Aug 2018	44	72.73	27.27
Sep-Dec 2018	90	68.88	31.12
May-Aug 2019	63	74.60	25.40
Sep-Dec 2019	102	79.41	20.59
May-Aug 2020	71	77.46	22.53
Sep-Dec 2020*	118	88.98	11.02
May-Aug 2021*	79	91.13	8.87
Sep-Dec 2021*	137	89.78	10.22
May-Aug 2022*	95	93.68	6.32

* Using the video game

The use of video games in the classroom has been a topic of discussion in recent years. Supporters mention that students should be taught with things that appeal to them, since with the advance of technology traditional methods have lost strength and interest, so it is necessary to use video games to bring students closer to didactic subjects. Detractors mention that video games have problems of violence, addiction, isolation and sexism, so they divert attention from priority educational problems and generate aggressive or pathological behaviors. The reality is that the opinions expressed by players about video games are extremely varied, from curiosity to indifference to fascination, although the general opinion is of acceptance of them (De Aguilera, 2013)

People cannot ignore the changes that occur in society and the impact they generate on education, with teachers using ICT as a didactic strategy. This new condition can be an alternative to break the monotony and boredom that characterizes certain school spaces that have little congruence with what happens outside them. Green and McNeese (2007) suggest that teachers' reluctance to incorporate digital games in the classroom is inconsistent with the influx of college students who grew up with them. Digital games remain an option to improve educational curricula in order to increase retained knowledge (Wiggins, 2016).

7. Conclusions

Nowadays, it is vitally important for the community to be involved in the production processes that concern them, as this increases the sense of belonging and identification of people to their community. For this reason, the design, development and implementation of an educational video game on algebra was carried out for students of the math course of Animation and Visual Effects Engineering, having as

main feature the participation of a large part of the students' community in each of the stages, from the script to testing. The goal is for students to do a daily activity they enjoy, such as playing video games, and at the same time reinforce their knowledge about algebra. Obviously, it was a complex job, since each student has a different vision that is determined to implement. However, as time goes by, and through the opinions of the entire community on various technological platforms, a consensus was reached on the work. The project was carried out in approximately 10 months and about 400 students participated. By testing the video game in various groups, the students managed to succeed at various levels and improved their score on the written exams that were applied to them, which resulted in a lower failure rate compared to previous generations. In addition, the comments were positive, as it served as feedback of the things they could do in the career. Therefore, a math video game is a teaching learning method with a promising future.

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