Classroom VR: a VR game to improve communication skills in secondary-school teachers

Classroom VR: un juego en RV para mejorar las capacidades comunicativas de profesores de secundaria

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Resumen

Según los informes de prácticas de capacitación de los futuros maestros de educación secundaria, existen importantes deficiencias en las aptitudes de comunicación necesarias para dirigir adecuadamente una clase. A pesar de la existencia de módulos relacionados con la comunicación en los maestros de enseñanza, no hay un aprendizaje real en esta área, y los estudiantes (los futuros profesores) expresan su temor cuando se trata de manejar una clase.

Actualmente, la realidad virtual está presente en diferentes campos, como la medicina, la ingeniería, las humanidades, etc. Sus características (en particular la relativa a la creación de un entorno seguro, su ubicuidad y su alta capacidad de inmersión) la convierten en una tecnología ideal para la formación de habilidades de comunicación. Paralelamente, en los últimos diez años, los videojuegos han demostrado su eficacia como herramientas de aprendizaje, solos o combinados con otras estrategias pedagógicas.

Por estas razones, consideramos la siguiente hipótesis: La realidad virtual en combinación con los videojuegos es, por un lado, un entorno eficaz para simular situaciones realistas relacionadas con la enseñanza secundaria y, por otro, un entorno ideal para practicar y aprender habilidades de comunicación para el aula.

Teniendo esto en cuenta, hemos creado un entorno virtual que sirve como herramienta de formación para los futuros profesores de secundaria, para mejorar sus habilidades de comunicación y acostumbrarse a una clase real. Simula una clase de secundaria con estudiantes y funciona como un videojuego. Los estudiantes virtuales simulan el comportamiento de los estudiantes reales en el aula.

Los futuros profesores empiezan el juego delante de la clase, como en la mayoría de las escuelas secundarias. La herramienta establece el fondo del juego, ofreciendo un contexto completo, acciones o comportamientos previos (por ejemplo, dos estudiantes han estado peleando toda la semana anterior). Después, el usuario tiene que reaccionar como en una situación real, manejando situaciones complicadas. Nuestro videojuego analiza en tiempo real el comportamiento del usuario (tono de voz, distancia entre el usuario y el o los estudiantes problemáticos y detección de vocabulario asertivo o negativo) y reacciona a través de los propios estudiantes, es decir, ofreciendo un

comportamiento realista a las acciones del usuario.

Somos optimistas sobre las posibilidades de nuestra herramienta en la formación de los profesores, ya que evita las costosas y complicadas prácticas logísticas en entornos reales. Los expertos consultados coinciden en el valor añadido que esta herramienta puede ofrecer a las prácticas en escuelas reales. El videojuego ofrece el entorno perfecto para aprender y comprender cómo manejar situaciones estresantes a través de una comunicación efectiva antes de enfrentarse a estudiantes reales.

Palabras clave
Videojuegos, Educación, Realidad virtual, Enseñanza, Juegos serios.

Abstract

According to the reports of training practices from future secondary-school teachers, there are significant shortcomings in the communication skills required to properly manage a class. Despite the existence of modules related to communication in the educational masters of teaching staff, there is no real learning in this area, and students (the future teachers) express their fear when it comes to dealing with a class.

Currently, virtual reality is present in different fields, such as medicine, engineering, humanities, etc. Its characteristics (in particular the one concerning the creation of a safe environment, its ubiquity, and its high immersion capacity) turn it into an ideal technology for training communication skills. In parallel, in the last ten years, video games have proven their effectiveness as learning tools, alone or combined with other pedagogical strategies.

For these reasons, we consider the following hypothesis: Virtual reality in combination with video games is, on the one hand, an effective environment for simulating realistic situations related to secondary education, and, on the other, an ideal environment to practice and learn communication skills for the classroom.

Taking this into account, we have created a virtual environment that serves as a training tool for future secondary-school teachers, to improve their communication skills and get used to a real class. It simulates a secondary-school class with students and works as a video game. The virtual students work by simulating behaviors of real students in the classroom.

Future teachers start the game in front of the class as in most secondary schools. The tool sets the game background, offering the complete context, actions, or previous behaviors (i.e., two students have been fighting all over the previous week). After, the user has to react as in a real situation, managing complicated situations. Our video game analyses in real-time the user's behavior (voice tone, the distance between the user and the problematic student or students and detection of assertive or negative vocabulary) and reacts through the students themselves, i.e., offering realistic behavior to the user's actions.

We are optimistic about the possibilities of our tool on the teachers'training since it avoids the expensive and logistical complicated real environments

practices. The experts consulted agree on the added value that this tool can offer to practices in real schools. The video game offers the perfect environment to learn and understand how to manage stressful situations through effective communication before facing real students.

Keywords
Video games, Education, Virtual reality, Teaching, Serious games.

Index

List of Figures

List of Tables

Chapter 1

Introduction

The lack of communication skills training in many developed countries is a fact. European Union has warned of the need to take action to enhance Europeans oral communication skills. Teachers are not an exception. (European Comission, 2020) Around the world, teachers are not adequately trained, and their lack of communication skills is notorious. (Hoffman et al., 2004) As a result, many of them leave their jobs in their first year due to frustration and other mental health problems (Fukuda et al., 2017). Particularly in Spain, there is no systematic treatment of communication issues, and most teachers do not receive specific training in oral expression. (García Aróstegui, 2008)

Several approaches are trying to solve this aspect inside the master's degrees in teacher training (Universidad Complutense de Madrid) (Universitat de Barcelona). However, the results obtained show that the development of these skills has significant shortcomings (Segovia et al., 2010) as there is no specific subject to improve communication skills. Instead, basic notions are taught in other subjects, which are insufficient, and practical sessions on this topic are short and given by teachers who don't have full knowledge of the issue.

On the other hand, advances in technology have much contributed and in different ways to society, ranging from the treatment of mental health problems such as post-traumatic stress disorder (Rothbaum et al., 1999), social anxiety (Anderson et al., 2003) or phobias (Rothbaum et al., 1996), to the training of workers (Frank et al., 2002), in addition to new ways of teaching students in different disciplines such as theatre (Prada et al., 2000), dance (Chan et al., 2010) or geometry (Kaufmann et al., 2000). One of the advances that have contributed most to making this possible is virtual reality, which makes it possible to create very immersive environments. (Rubio-Tamayo et al., 2017)

As part of the Didascalia group, we were encouraged to find a way to help teachers face a classroom full of students who would behave unexpectedly. Our proposal is a virtual reality-based video game. By developing a simulator

with a virtual classroom full of students whose behavior can be scripted, we could provide teachers with different situations to see how they would react and give them feedback based on their actions.

To develop such a video game, we would need examples of real-life situations that happen inside a class. For this purpose we got in contact with our project partners, who were professors from the University of Barcelona (UAB). They provided us with detailed scenarios that took place in real classes. We proceeded to integrate said situations into our video game, with students who would react according to what the player did to solve the problem.

This approach would help teachers to give an actual lecture and know which actions would have a better outcome for the class, dealing with conflictive situations which will be helpful for their professional career. So, our video game/simulator is addressed to future teachers who would want to experience how teaching a class is like.

We had the chance to write a paper on the resulting video game and send it to the EDULEARN20 (Edulearn) International Education Conference, with the name "A VR GAME TO IMPROVE COMMUNICATION SKILLS IN SECONDARY-SCHOOL TEACHERS", which was accepted. Due to the sanitary situation, the conferences could not be held in person, so we made a presentation video to be submitted instead. (Video Presentation)

1.1. Objectives

The main goal of our project was to create a tool capable of helping future teachers to face conflicts in a classroom and reduce their stress level in real-life situations.

Other objectives were the following:

- To carry out a study of the existing virtual reality tools related to education and teaching.
- To simulate a secondary education classroom with virtual students with realistic behaviours.
- To develop a video game which accurately reflects a real-life classroom with students who behave in different ways.
- To give detailed feedback to the teachers that may use this tool, informing them about their performance.
- To allow future researchers to gather data on what would be the reactions from the teachers to the different situations presented to them.

Chapter 2

State of the art

In this chapter we will cover the problem of current education, the characteristics of video games and virtual reality, the application of virtual reality to education and different tools used for creating video games.

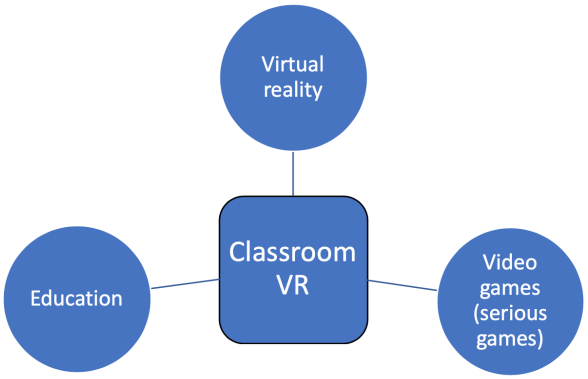

Figure 2.1: Components of our project

2.1. The problem of current education

Conflicts are one of the main concerns of teachers, tutors, parents and educational institutions (Jurado-de-los Santos y Tejada-Fernández, 2019) (MAHVAR et al., 2018). Respecting and maintaining order in the classrooms are activities to which a great deal of effort is devoted on a daily basis without, in many cases, achieving the expected results.

According to the ANPE syndicate, conflict in the classrooms occurs at younger and younger ages. (Europa Press, 2019) Moreover, the reports of training practices from future secondary-school teachers say that there are significant shortcomings in the communication skills required to properly manage a class. Despite the existence of modules related to communication

in the educational masters of teaching staff, there is no real learning in this area, and students (the future teachers) express their fear when it comes to dealing with a class. (Flores y Fernández-Castro, 2004)

2.1.1. Teacher training and conflict management techniques

The current training process of future teachers in Spain is as follows (Universidad Complutense de Madrid):

From September to February, teachers have more practical subjects and then more theoretical ones. Then, starting in February they have a practicum that lasts 3 months being assistant teachers in institutes, with a master teacher who guides them. However, they also must teach some lectures. After that the training is over, so it's not enough time to get used to teaching in a real classroom. Because of this, they are still very anxious, and 52 % of the future teachers think they are not sufficiently prepared. (ABC, 2019)

Regarding conflict in classrooms, the teacher must know how to use it skillfully, regulate it and treat it positively. For this purpose, They must use mediation and negotiation. (MAHVAR et al., 2018)

Both are complementary ways of managing conflicts, with mediation being one way of carrying out the negotiation. These terms are especially important for mitigating the factors that cause violence in education.

There are two basic types of negotiation: collaborative and competitive. (Thomas, 2013) In collaborative negotiations, both parts look for an adequate solution to their demands. This is the system of negotiation that should prevail in schools, since there is an affective bond and equality.

Conversely, competitive negotiation is based in personal positioning without putting oneself in the place of the other part. This approach should be used with caution because it can promote more serious conflicts than the initial ones.

With our tool, we are going to try to identify how this negotiation is approached and give feedback to the users in order to improve their skills when it comes to dealing with conflicts.

On the other hand, mediation derives directly from negotiation and involves the physical presence of a person who tries to neutralize the resulting behaviors in a conflict. The teacher is the one who usually acts as a mediator in schools, being the person who helps to create a good environment in the classroom. (Vallejo, 2005)

2.1.2. The Four Pillars of Learning

According to the report for UNESCO on Higher Education by Jacques Delors, education should be structured around four pillars of knowledge. (Vallejo, 2005) In any educational system, each of these pillars should be

given equivalent attention in order to make education a comprehensive and lifelong experience at the cognitive and practical levels.

These four pillars are:

- Learning to know: acquiring the tools that allow the subject to understand the world around him.
- Learning to do: the capacity to influence one's environment, putting into practice the knowledge learned.
- Learning to live with others: participating and cooperating with others in the various human activities. Respecting the values of mutual understanding and peace.
- Learning to be: through education, people should possess autonomous and critical thinking, as well as their own judgement about things. Aspects such as imagination and creativity are very relevant in this pillar.

Encouraging teamwork is the best way to act in conflict prevention and resolution. Sometimes, group activities are proposed, but teachers do not dive into interpersonal relationships that occur among the students.

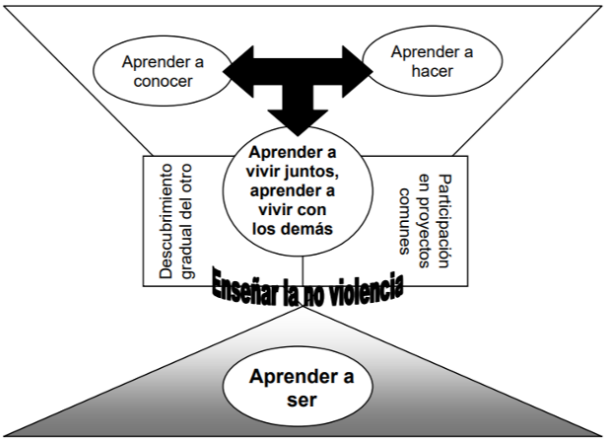

Figure 2.2: The Four Pillars of Learning (Vallejo, 2005)

2.2. Video games

The video game industry has experienced a huge increase in interest from the population in recent years, especially among young people. By 2018, the United States video game industry had matched that of the United States film industry in terms of revenue. (Minotti, 2019) (Robb, 2018)

According to Microsoft, there are more than two billion gamers around the world, including everyone from those playing free games on their phone to those using a computer fitted with the latest hardware. (Webb, 2019)

Video games have become a part of many people's daily lives. However, we should not think of them only as an entertainment, since they can be extended to a wide variety of functions. But before we go any further, it is essential to define what a video game is for the purpose of understanding this project.

2.2.1. What is a video game?

It is difficult to find a single definition for this term, since video games are present in many aspects of human beings today.

Every day new types of video games are created that can have very diverse applications, from simple entertainment to the education of students, including physical exercise.

However, according to Nicolas Esposito (Esposito, 2005), this definition could work:

A video game is a game which we play thanks to an audiovisual apparatus and which can be based on a story.

Following this definition, we must also clarify what exactly is a game. Eric Zimmerman describes it as a "voluntary interactive activity, in which one or more players follow rules that constrain their behavior, enacting an artificial conflict that ends in a quantifiable outcome". (Esposito, 2005)

Playing would be the free space of movement within a more rigid structure. A voluntary activity or occupation executed within certain fixed limits of time and place, according to rules freely accepted but absolutely binding.

Playing has some benefits such as the pleasures of competition, accomplishment, system mastering, narrative enjoyment and audiovisual experience. However, these benefits are also useful in many other aspects beyond entertainment, as we will see later.

Talking about the audiovisual apparatus, this refers to the electronic system with computing capabilities, input devices and output devices. This means that there are human-computer interactions and that video games can be seen as user interfaces. In this way, the interactivity is the factor that makes the major difference between video games and games.

In the case of virtual reality, this interactivity is enhanced in a much more immersive way for the player, who can experience a simulation of a real environment. Finally, the story is the element in which a game can be based, but not in all cases. There are many ways to insert narrative elements in a video game, such as back-stories, cut-scenes between levels or conversations between characters.

However, according to Celia Pearce, "games have a play-centric context. They center in play, unlike literature and film, which center in story. In games, everything revolves around play and the player experience." (Pearce, 2004)

This is why there are video games like Tetris. They don't always need to be based on a story.

2.3. Virtual reality

Virtual reality, or VR for short, is a computer-generated simulation which places the user inside a 3D artificial world in which he/she can interact with the environment as if it was real. This allows for the creation of realistic scenarios that can be used for various purposes, such as education, entertainment or social science.

Most of the current virtual reality systems use a virtual reality headset, a device which the player places in his/her head and displays the environment through two different images, one for each eye. (Oculus) It also provides sound and tracks the movements of the player's head, so that the view can be changed according to where the player looks physically.

As well as that, some VR systems also contain controllers which are especially useful for video games, since they help the player move around the virtual environment without walking around in the real world. (VIVE) They can also be used to point to a specific object, like a mouse, among other things.

Figure 2.3: VR headset from HTC and two controllers (HTC)

Video games are one of the most common applications of VR. Since VR allows the player to get inside a virtual world, it is the most realistic depiction of an environment that can be made, and thus provides the perfect setting for a video game that is intended to provide an immersive experience.

Despite all this, VR is not the most common technology for developing nor playing video games. This is due to its high cost, the lack of VR video

games and the convenience that a small console offers over a bigger system which requires space around the player to work. (VALVE)

2.4. Virtual environments applied to education

2.4.1. Serious games or educational video games

Serious games are usually defined as games used for purposes other than mere entertainment. (Susi et al., 2007)

The purpose of this type of games is creating learning environments that allow us to experiment with real world problems. In this way, serious games help us explore different solutions to problems posed in real situations and discover the information and knowledge that would help to be able to intervene without fear of error. The lack of real-life consequences facilitates the decision-making process, teaching us the optimal choices in those situations and helping the development of different skills. (López Raventós, 2016)

This is an extremely powerful tool that makes possible the creation of virtual environments that would be impossible in the real world for reasons of safety, cost, time, etc. (Susi et al., 2007)

2.4.1.1. Serious games applications

Some markets where serious games are used can include military games, educational games, healthcare games, etc. (Susi et al., 2007) In this section we are going to see some examples in order to have a context for the better understanding of this project.

a. Edutainment

One of the most common terms used for the classification of this type of games is edutainment, coming from education and entertainment. (Okan, 2003) These games try to teach players by presenting information in a more fun way, using animations or multimedia tools or by including puzzles or memory games.

Major companies in the video game entertainment industry have also created such games in order to bring together the interests of students and players to a single place.

In 2018, Ubisoft launched Assassin's Creed Origins: The Discovery Tour (Ubisoft, 2018), a virtual museum with guided tours and historical sites to discover that allows players to explore Ancient Egypt. This commercial game has been used for conducting studies for comparing the learning outcomes of a group following the game's tours with those of a group learning about the subject from a teacher, who used still images from the same tours. (Engadget, 2018)

The results showed that those who had the teacher's guidance improved their grades up to 55 percent, concluding that a hybrid approach of video games and traditional instruction could further enhance learning.

Figure 2.4: Assassin's Creed Origins: The Discovery Tour (Ubisoft, 2018)

Other tools have also been used in schools in order to help children and their teachers in the learning process. TEATRIX (Prada et al., 2000) was designed in order to assist in the whole process of collaborative story creation. It allows children to interact with each other in a distributed 3D environment, choosing a character which will be controlled by the children or will act autonomously according to the actions and goals set up by their role in the story.

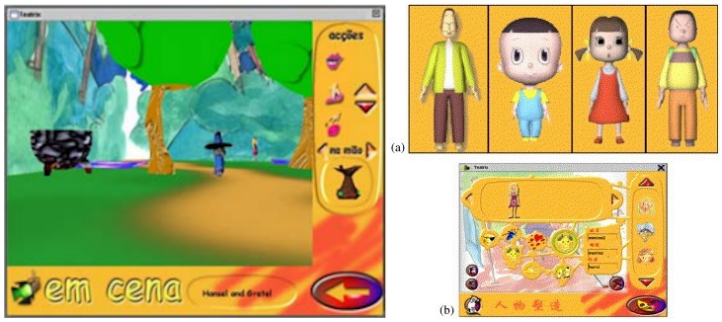

Figure 2.5: Teatrix (Prada et al., 2000)

b. Educational games

These games are explicitly created with the intention of teaching, without trying to prioritize the diffusion of certain contents in the most playful way possible.

Construct3D (Kaufmann et al., 2000) is a three-dimensional geometric construction tool that uses a stereoscopic head mounted display and a two-handed 3D interaction tool that simplifies 3D model interaction. Its application in mathematics and geometry education is interesting for its use at high school as well as university level.

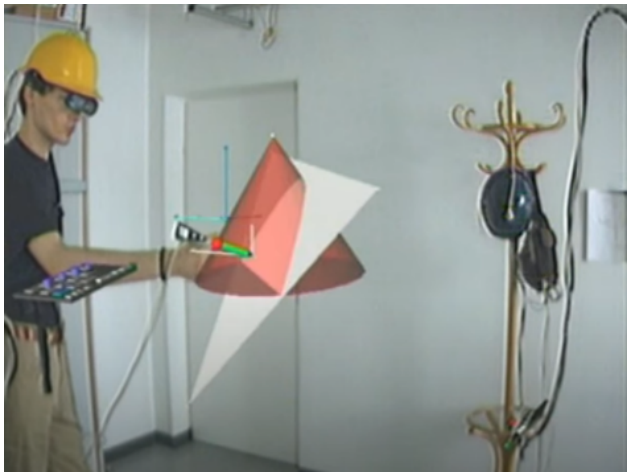

Figure 2.6: Construct3D (Kaufmann et al., 2000)

Another example is an educational tool for dance training. (Chan et al., 2010) This game integrates virtual reality with a motion capture system to analyze the user's movement and give feedback. An interesting application of this tool can be inside a classroom where the students have to follow the teacher's movements.

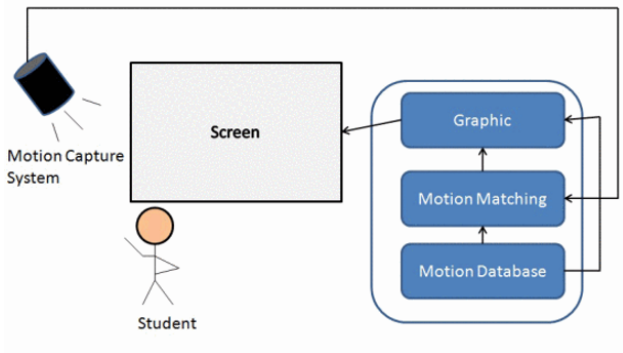

Figure 2.7: The motion capture system (Chan et al., 2010)

Finally, Dancing a Treasure (Romero-Hernandez et al., 2019) is another educational game concerning Spanish dance, whose purpose is to motivate young people to learn about this field, showcasing its basic moves and elements. It was developed for mobile devices, with the collaboration of the

Spanish National Ballet company. (BNE) The game is composed of different screens with several difficulty levels where the player must tap on the screen to follow the dance moves being performed.

Figure 2.8: Dancing a treasure

c. Games for health

In the field of health, applications have been developed in which video games serve as a vehicle for a variety of functions, such as training medical students and general medical personnel. (Dinsmore et al., 1997)

Many of these games are designed as psychological therapy, being useful for all kinds of patients. From Vietnam combat veterans with posttraumatic stress disorder (Rothbaum et al., 1999), where patients are exposed to virtual environments such as a Huey helicopter flying over a virtual Vietnam and a clearing surrounded by jungle; to patients with social phobia and anxiety (Anderson et al., 2003), who are presented with a virtual classroom environment in order to mitigate their speaking fears.

d. Companies, institutions and business corporations

Serious games are also used by companies to train their own employees in new skills and resources. (Azadegan y ckh Riedel, 2012)

This type of games represents a very important time and money saving for companies, in addition to reducing the usual rejection of employees to this type of training. This training mode makes it easier for participants to think of themselves as active rather than passive agents in that training, while the trainer becomes a guide rather than a teacher, thus generating greater dynamism in the process. (López Raventós, 2016)

JUST-TALK (Frank et al., 2002) is an application of responsive virtual humans to train law enforcement personnel in dealing with subjects that present symptoms of serious mental illness, providing a computerized virtual

person to interact with the student in a role-playing environment.

Students will be able to conversate with the virtual person using spoken natural language, and see and hear the virtual human's responses: a combination of facial gesture, body movements, and spoken language, showing students basic techniques for managing encounters with the mentally ill. It also teaches them to look for indications of particular forms of mental illness so that they can adapt their responses appropriately.

Figure 2.9: JUST-TALK (Frank et al., 2002)

2.4.1.2. Serious games at Universidad Complutense de Madrid

a. The ComunicArte (PR2005-174/01) project

ComunicArte (PR2005-174/01) (ComunicArte) was created in the Universidad Complutense de Madrid (from now on UCM) with the aim of teaching public speaking by using video games in VR environments. For this aim, a team was created with members who had experience in the fields of educational video games, computational narratology, affective computing, art, psychology and VR. This project took place over two years, and obtained financing from the Fundación BBVA, amongst nine other projects in Spain. (BBVA, 2017)

The result of this research is a method of learning through an immersive environment in which the player is taught how to deal with a real audience. (El-Yamri et al., 2019) Information about the player is recorded -biometric measurements, voice analysis, body movements and speech- and valued in regards to a model of the virtual public, which allows to give the player advice to improve his/her communication skills. This would serve as a prelude to real audiences, which are far more difficult to obtain and where opportunities to practice speaking skills are more limited.

Our project is closely related to ComunicArte, since it also consists on the implementation of a virtual environment in which the player is presented

with an audience (in our case, a classroom with students) that would react in a particular way according to what the player says or does, providing feedback. As well as that, our video game also aims to improve the player's communication skills.

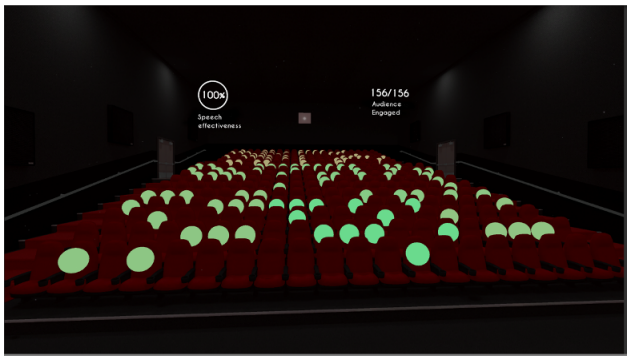

Figure 2.10: The ComunicArte project (ComunicArte)

b. The Didascalia (RTI2018-096401-A-I00) project

Didascalia (RTI2018-096401-A-I00) is a project created as an extension of ComunicArte in the UCM, with the aim of creating and proving the efficiency of a virtual environment, in VR, that can be used as practice both for students in teaching masters courses as well as teachers who are already teaching in secondary school. Part of the members of Didascalia are members of ComunicArte, including our directors.

Didascalia attempts to make use of the existing advances developed in ComunicArte to create new scenarios set in a classroom, where teachers will have to face questions or conflicts that may arise while giving a lecture, receiving feedback from the system regarding their performance and communication skills to solve said conflicts. However, the parameters to take into account greatly differ from the previous project, since the new proposal has a much more specific scope and will focus on teaching communicative skills to a secondary-school teacher, not an ordinary speaker.

Our project is positioned inside Didascalia, acting as the core of the development of its first prototype. Thus, the video game we want to develop will be an initial environment that will promote the project and serve as a base for the upcoming two years of research.

2.5. Video game creation tools

Video games are created thanks to game engines. A game engine is a set of programming libraries that allow the design, creation and representation of a video game.

One of the most important aspects when choosing a specific game engine among all of the ones available in the market are the graphic capabilities, because they are in charge of showing the 2D and 3D images on screen as well as calculating some aspects such as the lightning and the textures.

Other characteristics to take into account are the ease of exporting the game to different platforms or the usability of the engine.

In this case we are going to talk about Unity and Unreal Engine, currently the two main game engines in the market.

2.5.1. Unity

Unity (Unity) is a game engine that allows the creation of 2D and 3D video games. It is the most widely used tool for creating video games in the world, and it is estimated that sixty percent of all virtual reality video games are developed using this engine. (Bonfiglio, 2018)

Unity is a cross-platform game engine. The Unity Editor is supported on Windows and macOS (it is still experimental on Linux). The engine supports creating games for more than 25 platforms that include mobile (iOS, Android), desktop (Windows, Mac and Linux) or console (PlayStation, Xbox or Nintendo).

The programming language that Unity uses is C#. Using this language, the developer can build scripts which can be made for several purposes:

- To adapt the game to player input.
- To arrange events inside the game.
- To set the behavior of the characters in the game.
- To create visual effects.

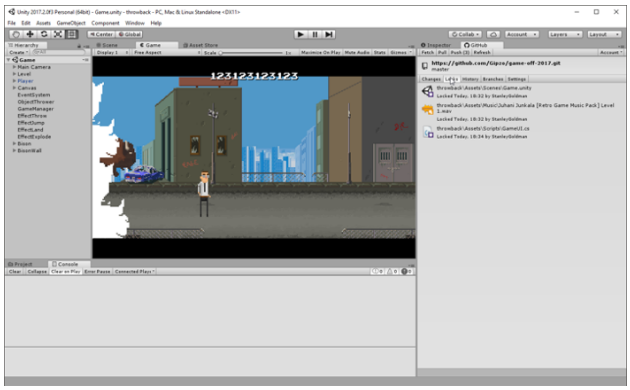

Figure 2.11: The Unity game engine (Github For Unity)

Apart from this, Unity offers a service called Unity Asset Store (Unity Asset Store) which allows developers to install Assets in their projects. Assets can go from simple functionalities in the Unity IDE to large 3D files for a video game in 4K definition.

2.5.2. Unreal Engine

Unreal Engine (Epic Games) is one of the most popular game engines. It's a complete suite of development tools based on the C++ language that includes all the necessary elements to build a video game or an interactive environment in virtual reality for several platforms, such as PC, PS4, iOS and Android.

Initially, Unreal Engine emerged as an engine for the creation of video games of the shooter type, but has evolved over time, expanding to different game modes.

Unreal Engine presents a high degree of portability and is nowadays widely used by a lot of video game designers. Its most recent version is Unreal Engine 4, although Unreal Engine 5 is currently in development phase. (Epic Games)

To create video games with Unreal Engine, the process consists on working together with the Unreal Editor and with programming, either by programming in C++ directly or with Blueprints (Epic Games), which is an ideal proposal for those who don't have the knowledge of programming languages.

The Unreal Editor is an integrated development environment. It serves as a user interface, where the developer sees the current state of the game being created and the menus or tools available. With support for multi-user editing (Epic Games), designers can simultaneously make changes to the same Unreal Engine project in a safe and reliable way.

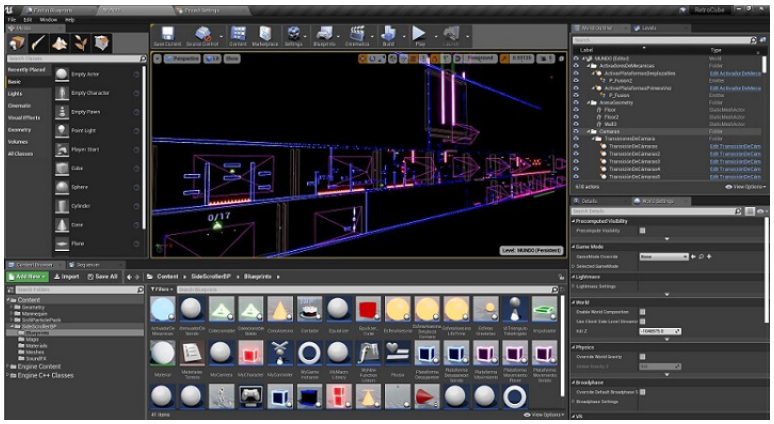

Figure 2.12: Unreal Engine (MasterD)

Chapter 3

Development and implementation

Here we cover the whole process of creating and developing the video game, following the instructions provided by education professionals.

3.1. Design of scenarios

This section explains the process to obtain the scenarios, from an initial idea to a full description of the implementation details with Unity.

3.1.1. Selection criteria

The analysis was carried out by professionals from the Universidad Autònoma de Barcelona, who selected the scenarios based on a first approximation to the records of an institute known by one of the experts that participate in the project.

These reports included the most common infractions committed by students of said institute, and its analysis will be explained in the next section. The knowledge of the context was here a weight factor.

The content of the reports was insufficient for the design of the scenarios, since there was a lack of background information that is normally not recorded on them.

The creation of the scenarios was mainly based on the behaviour of the students. Among the most frequent incidents that the pedagogues found, we selected two. One puts the core of the conflict on the teacher's communication with a student, while in the other one, the conflict involves more students. In addition, a third situation was created that also focuses on a conflict involving several students.

Since it is required to design interactive communicative situations between the teacher and the students, complementary contents were proposed

to design the teacher's answers.

3.1.2. Obtaining the reports

In order to gather all of the necessary reports, the schools were contacted directly, through the educational psychologist or counsellor who is linked to them. Every secondary school has such a figure.

Centers were selected based on two basic criteria: public ownership and socially and culturally diverse population. Both criteria favour the representativeness of the population, both students and teachers. The second criterion is fundamental because the socio-cultural composition of the groups can theoretically be associated with a greater conflict. (Ridenour, 2004) The communication process to obtain consent for participation was as follows:

First, in a brief interview, the researcher representing the project informs about the objectives as well as the expectations regarding their collaboration. Having obtained his or her approval, the school psychopedagogue informs the director and, if he or she considers it viable, submits the application to the faculty, since it is the latter who must give their consent to use their discipline reports as the object of study. Throughout this chain of communication, the project is presented through a piece of text (informed consent) that is finally returned signed by the director of the center that agrees to collaborate in the project.

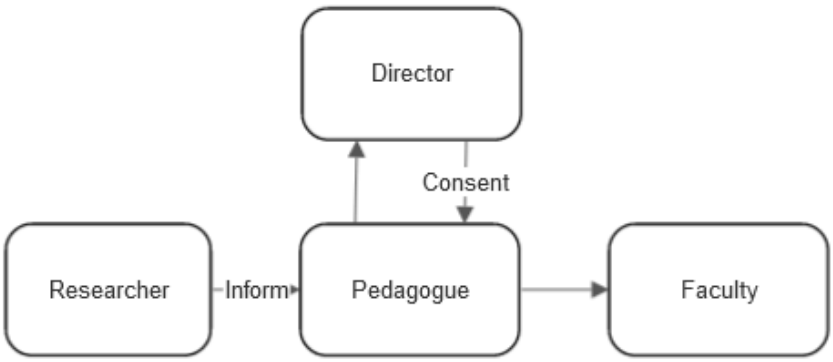

Figure 3.1: Communication process diagram

There are three centers involved so far, all of them public: one in Barcelona and two in Vic (not named for ethical commitment). In two of the centers the discipline reports were digitalized in an Excel sheet. In the other one they were on paper and their content was also digitalized to facilitate

their analysis. Although they are very short reports, we were able to obtain essential data to study the communicative situation that must be simulated later in the scenarios: reason for the conflict, subject in which it occurs; students involved (individual or group incident); time of the class in which the conflict is detected (at the beginning, during the class, at the end) and recidivism by the student or students involved in the conflict. In addition, personal variables were recorded such as sex and course for students and the experience of teachers (novice or expert).

Based on the results of this preliminary analysis, reports of serious indisciplines (e.g. those referring to mistreatment of people or social property) were discarded and those that appeared more frequently in both boys and girls and occurred in core subjects were considered representative, as seen in Figure 3.2. Another criterion for selecting the report to be represented in the scenario was the individual or group nature of the incident, which in turn is related to the format of the communicative situation between the teacher and the students involved in the conflict.

Materias	**Casos reportados**	**Ejemplos**
Básicas (Lenguas, Matemáticas, Física-Química, C. Naturales, C. Sociales, Tecnología)	630 (49%)	A primeros de la clase he dicho a él y al Miquel que tenían que sentar separados, no porque hubiéramos hecho nada, sino por el qué había visto los otros días, que juntos solo hablan y no trabajan. Se han negado y no me han hecho ningún caso. Simplemente me ignoraban cuando se los he repetido. Ante esta falta de respeto y reconocimiento de la autoridad, he pedido que saliéramos del aula. No han respondido ni hecho caso. La delegada ha tenido que ir a buscar la jefa de estudios. (MATEMÀT. 2ESO) No lleva la libreta y lo he obligado a escribir en una hoja. Pues antes de acabar la clase ya se ha levantado de la silla para tirarlo a la papelera. (C. NATURALES 1-ESO) Parla con los compañeros mientras la profesora explica. Lo he avisado repetidas veces. Ha desconectado de la asignatura y le cuesta mucho escuchar y coger apuntes. No se quiere sacar los auriculares. Escucha con un volumen muy alto. Se lo ha avisado que no es bueno para su salud. No hace caso. Por el resto, trabaja bien, individualmente pero trabaja. Cuando quedaban 5 minutos para finalizar la clase en el aula de informática (se pueden levantar y ayudarse con moderación) he visto que Tomas le hacía una "colleja" bastante fuerte al Alberto. Él dice que primero Alberto lo había molestado pero en todo caso yo no lo había visto. . . .
. . .	. . .	. . .
	N= 1267	

Observaciones:

Los incidentes seleccionados se refieren a perturbaciones que afectan directamente al planteamiento docente (actitudes disruptivas que no permiten desarrollar la clase, uso inapropiado de materiales o herramientas, falta de atención a las normas, etc.). Hay otro tipo de incidentes en los que están involucrados los estudiantes (falta de respeto, agresiones, etc.) y otros que pudieran clasificarse como conductas más graves (racistas, agresivas, ...).

La mayoría de los incidentes se reportan en las clases de asignaturas básicas.

Es probable que abunden en los últimos cursos (3º y 4º).

En los incidentes son más frecuentes nombres de chicos.

Figure 3.2: Analysis of the disciplinary records from one of the institutes

However, some limitations were recognized in this study:

Firstly, given the rush to achieve a technically viable prototype, the analysis of the reports was not as rigorous as we would have liked. We are currently

conducting a more refined analysis to typify the conflicts based on the scientific literature and through Atlas.ti (Atlas.ti), a data analysis software. This procedure will give us better arguments to decide which situations should be represented in the scenarios.

Secondly, informed consent for students was not initially considered necessary. However, we believe that they should also be informed, even if it is without reference to any particular person. Apart from ethical considerations that must be respected, in the next phase of the research, students, like teachers, can provide useful information to understand conflicts based on their experience and assess how they approach the different ways of managing them.

3.1.3. Proposed scenarios

Three scenarios with a similar scheme were given to us by the educators. Each of them began with the description of an initial conflict, where the teacher had to make a choice. Depending on the action taken by the teacher, the player can follow different paths, each one with positive or negative consequences for the class. Afterward, feedback would be provided to the players, informing them about their performance.

These scenarios were explained to us through virtual calls with the educators, as seen in Figure 3.3.

Figure 3.3: Screenshot of the meeting with the educators (02 / 13 / 2020)

Each of them was thoroughly described through several slides that contained information about the scenario, with descriptive images and sample discussion on the consequences of each decision that the teacher could make (Figure 3.4).

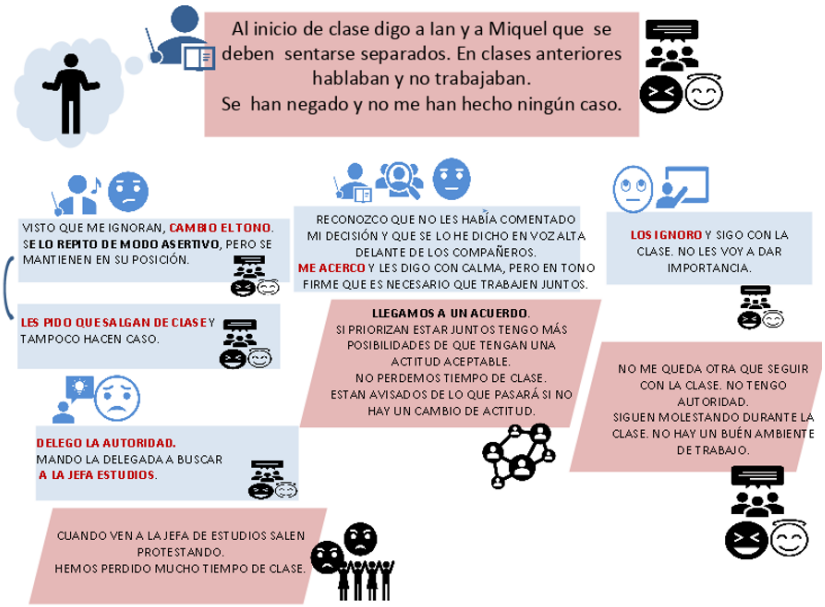

Figure 3.4: A scenario as depicted in the slides from the educators

Apart from these slides, the situations were described in the form of a flowchart made by the Barcelona pedagogues, one for each scenario, containing all the relevant information, as shown in Figures 3.5, 3.6 and 3.7.

3.1.3.1. First scenario: Inappropriate comment from a student

In this scenario a student says something aggressive towards the professor out loud, so other classmates pay attention to him. He tends to make these comments in class and is often warned by the professor to stop.

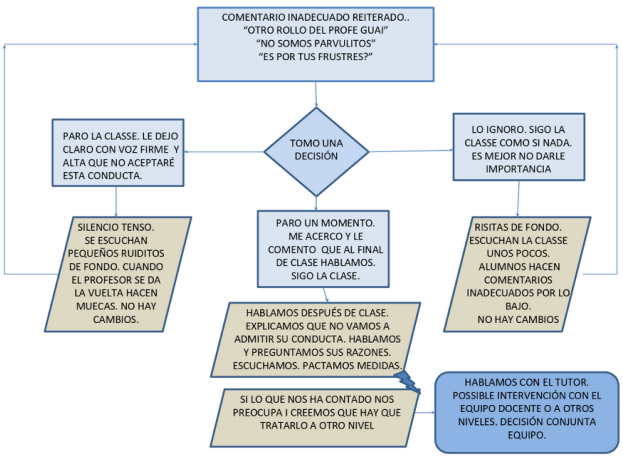

Figure 3.5: First scenario as proposed by the educators

3.1.3.2. Second scenario: Two students refuse to sit apart

In this case the problem is that two students are always sitting and talking together, without paying attention to the class and disturbing their classmates, who cannot focus on what the teacher says with the noise they make.

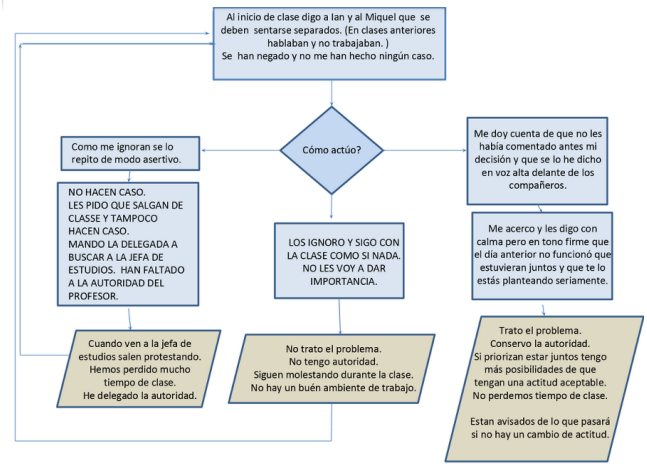

Figure 3.6: Second scenario as proposed by the educators

3.1.3.3. Third scenario: A student is not welcomed by his or her classmates

In this case the class is divided into groups, who are working together. In one of the groups, a student is not well received by the rest of the group, who do not pay any attention to him and laugh at him. He gets fed up and ends up leaving the group.

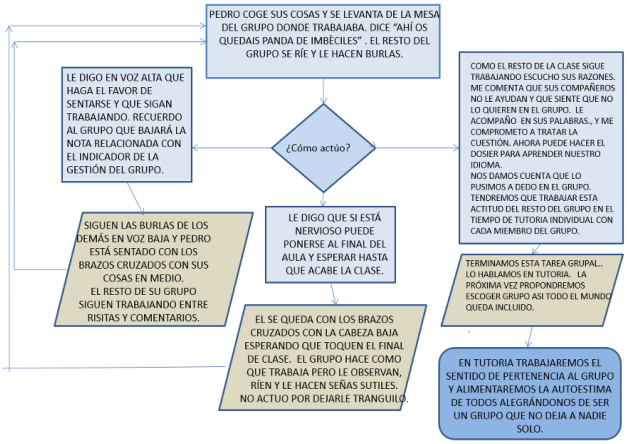

Figure 3.7: Third scenario as proposed by the educators

3.1.4. Adaptation of the scenarios to Unity

The next step towards building the video game was to adapt these diagrams (Figures 3.8, 3.9 and 3.10) to make them suitable for their implementation. To that aim, we created a new flowchart for each scenario that contained, for each possible situation, a description of how it would be represented in the implementation.

3.1.4.1. First scenario

An example of the translation process in this scenario can be observed by looking at the first path. In the original diagram, it says that the teacher stops the class with a firm voice. Thus, in the adapted chart, we wrote "Detect a firm voice tone", something that we could identify with Unity.

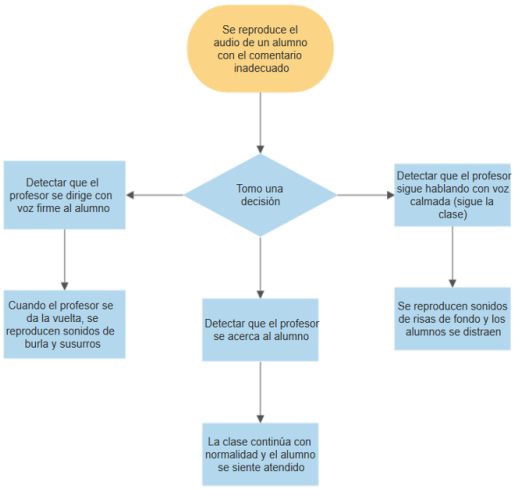

Figure 3.8: First scenario adapted to Unity

3.1.4.2. Second scenario

As another example, in the right path from the original diagram of this scenario, it is specified that the teacher approaches the students. The software we used to develop the video game (Unity 3D) contains features that allow monitoring if an object (in this case, the player) is within a specific range of another (the students). Thus, in the new diagram, this procedure is described as "Detect that the teacher approaches the students", to ease the implementation phase.

Furthermore, we decided that it could be interesting to detect if the teacher speaks in a high tone to the students, despite it not being part of the three original paths. Therefore, our pedagogues advised adding a fourth

path that considers this case, marked in green, to provide a better experience to the player.

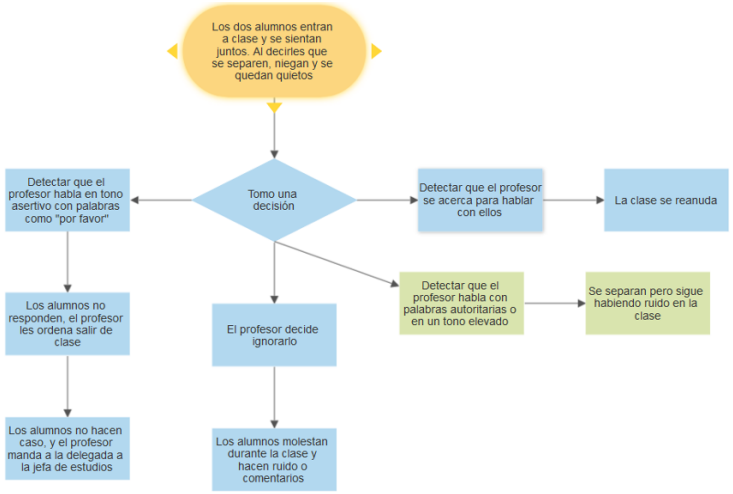

Figure 3.9: Second scenario adapted to Unity

3.1.4.3. Third scenario

In this last scenario, specifically in the second path, the teacher tells the student to sit in the back of the class until the lesson ends. Therefore, we translated it as detecting the words “end” or “back”, which would be recognized by a Unity tool called Keyword Recognizer, that will be later explained.

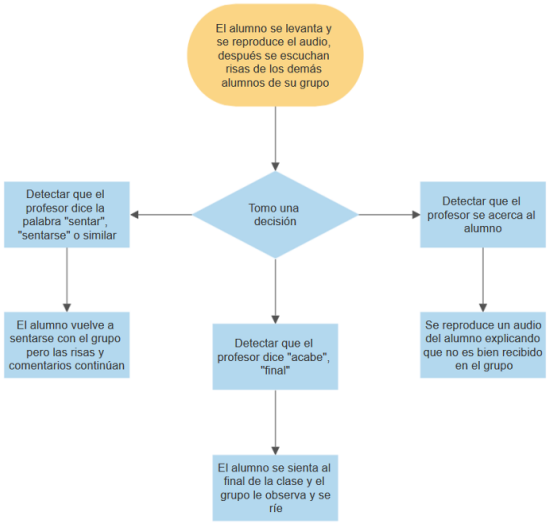

Figure 3.10: Third scenario adapted to Unity

3.2. Implementation

When selecting a game engine to develop this project, we decided to use Unity. One of the reasons of choosing this program over Unreal Engine was that there is a bigger community in Unity, having a good number of tutorials and manuals, as well as third-party content available for its use (Unity Asset Store). Another advantage is that Unity is easier and faster to learn, something crucial for us since we did not have any experience with video game developing engines.

In this part, we detailed the components that were part of the implementation of the video game, covering from the objects to the scripts.

3.2.1. Student models and animations

We created models of students using Adobe Fuse (Adobe), which is a graphics software creator that enables the creation of 3D characters in an intuitive and easy way. This program allows users to create figures from scratch and customize their body parts, clothing and facial expression. These characters are then rigged with a model and can be exported to different platforms.

Figure 3.11: Models created with Adobe Fuse (Wikiwand)

We decided to create a total of eight models. We found that eight students were high enough to represent all the proposed scenarios, and low enough so that it was not overwhelming for the teacher. Four of the students were boys, and four were girls. Since according to the Spanish Ministry of Education (Ministerio de Educación y Formación Profesional, 2019), 51 % of all secondary-school students are men, and 49 % are women. All of them were Caucasian, since that is the most common race among European schools, with just 9 % of international students in Spanish classrooms. (Ministerio de Educación y Formación Profesional, 2019)

After creating all the students, we used Adobe Mixamo (Adobe Mixamo), a tool used for animating the previous models. Mixamo is an online software that imports the characters from Fuse and lets the user choose amongst hundreds of different animations to assign them to the imported models,

thus creating a realistic, animated avatar to include in the game. In this manner, we were able to represent in a precise way disruptive behaviour of students in the classroom, such as cheering, laughing or getting distracted.

However, some of the animations were not properly configured and shifted the student's position in one of its axis. Thus, we edited these animations inside the Unity animation editor. As well as that, we searched for different animations for each student, so they would behave slightly differently and not move in the same way as the rest.

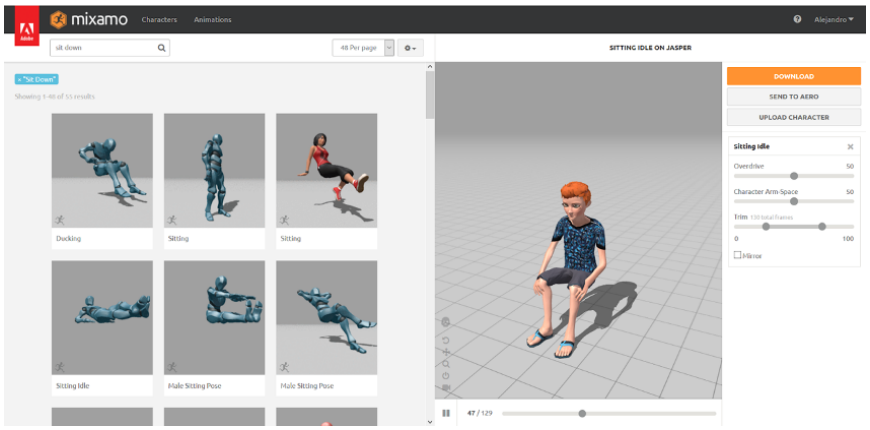

Figure 3.12: Animating a model in Mixamo

3.2.2. First draft of the class

Our idea was to create an initial environment with the eight students, with some pieces of furniture like chairs and desks that were available in the free asset packs in the Unity Asset Store (Unity Asset Store), as shown in Figure 3.13. This would serve us as a prototype to get used to working with Unity and as a base for developing a more complex scene later on, as it would already have some functionalities such as the students´ initial animations.

We imported the models from Mixamo into Unity and gave each of them a name: María, Dani, Alberto, Marta, Laura, Rebeca, Diego and Pablo. Then, we placed each of them in a chair in front of a desk facing towards the player.

By creating two different scripts, *PlayerMovement* and *MouseController*, as well as the Unity component *Character Controller*, we were able to create an object that allowed the player to move around using the WASD keys and look around using the mouse. Naturally, this would later be adapted for using Virtual Reality glasses and a controller.

Another idea was to implement a system to make students move around the classroom, for possible situations that may arise such as simulating a misbehaving student. Initially, the student would move towards the direction where the player clicked with the mouse. To make it more realistic, the

student would first play the animation of standing up and then another walking animation while getting to the destination, as well as a standing one when he or she has arrived.

We used the *NavMesh* and *KeywordRecognizer* classes to add a couple of features to our project. These two components will be explained in detail further on.

Using the *NavMesh* object, the students would be able to walk around the room freely but would not walk into or over chairs or desks.

Otherwise, the *KeywordRecognizer* class made it possible to integrate a mechanism by which the video game could recognize certain words that the player said. For example, when the player addressed a student by their name or told them to stay quiet, and this way we could set up certain reactions from the students accordingly. Moreover, we implemented a function that would find the student and change their animation to make the student raise their hand when addressed by the teacher.

Figure 3.13: The first draft of the class

3.2.3. Asset pack selection process

3.2.3.1. Initial asset pack

Once we had the first draft of the class done, we needed to adapt it to real components of a class to represent everything with maximum precision.

First, we started looking for asset packs from the Unity Asset Store trying

to find one that was quite complete. We looked at one in particular, which was called “Snaps Art HD - School”. (Asset Store Originals) This pack used HDRP (High Definition Render Pipeline) technology. (Unity Blogs)

The SRP (Scriptable Render Pipeline) is a system introduced by Unity in 2018 which allows the users to customize the rendering of their project based on their needs through C# scripts. This system is divided in two main components: The LWRP (Lightweight Render Pipeline) and the HDRP (High Definition Render Pipeline), both in preview phase. While the LWRP is focused in optimizing the real-time performance, the HDRP aims for high visual fidelity. Inside the HDRP you can customize aspects like lightning, shadows and materials.

When we downloaded the project and included the students from Mixamo in the class, several problems started to arise. First of all, the project was very heavy because of the number of elements it had, as the pack included almost a whole school built. Despite taking out everything but one class, it still occupied a couple of GBs, making it more difficult to use a version control system like GitHub.

The assets and textures also took up a lot of space because of their high quality of definition. But what affected us the most was that Unity gave us a problem when processing the children’s textures. They appeared without any colour and we couldn’t solve it. We spent a couple of weeks trying to figure out a solution to this, but we did not achieve anything.

Figure 3.14: The class with the first asset pack “Snaps Art HD - School”

3.2.3.2. Final asset pack

As a result of these problems, we decided that the best thing to do was to look for another pack that was much simpler and lighter, but above all, that was compatible with a Unity 3D project without the use of HDRP, which would allow us to integrate all the elements well.

Moreover, we decided to gather information about the characteristics of a real classroom, so when designing the setting we took a typical Spanish secondary-school classroom as a reference. Its main components were the desks and chairs, the blackboard, and a platform for the teacher with a lectern. To this end, we decided to use an asset pack from the Unity Asset Store named "Classroom", which included all the necessary elements.

Figure 3.15: Our class compared with a typical Spanish class

We decided to include thirty seats for students since that is the maximum number of students per classroom according to Spanish law. (Ministerio de Educación, 2010) Another design decision was to place the teacher in a plat-

form, higher than the students, a common feature of classrooms that allows the teacher to see and be seen by all the students. Initially, the teacher is facing the students, as the scenarios require him/her to be able to observe their behaviour.

Apart from that, we assigned to each student a label with his/her name to help the player to be able to address them. Labels are important for the communication between teachers and students since students can benefit from perceiving that instructors know their names. (Cooper et al., 2017)

Figure 3.16: Students in the final class

3.2.4. Implementation of the menu

The next step was to build a menu based on a typical design, which would be friendly and guiding for the player, and through which the different scenarios could be accessed.

The first thing we did was create a new scene called Menu. Then, inside this scene, two objects were created representing the main menu and the submenu. Each one of these objects contained all the components we needed, which were a canvas object, a background panel, the buttons and the texts associated with the buttons.

The operation of the buttons of the two menus was as follows:

- Main menu
  - Jugar: this button led to a submenu that served to choose the game scenario the player wanted to experience. The transition to the submenu was done by hiding the main menu component and showing the submenu component.
  - Salir: this button exited the game.

Figure 3.17: Main menu

- Submenu
  - Escenario 1, Escenario 2 and Escenario 3: these buttons loaded the class scene with the corresponding scenario ready to be played by means of a script.
  - Volver: this button returned to the main menu. This action was achieved hiding the submenu component and showing the main menu component again.

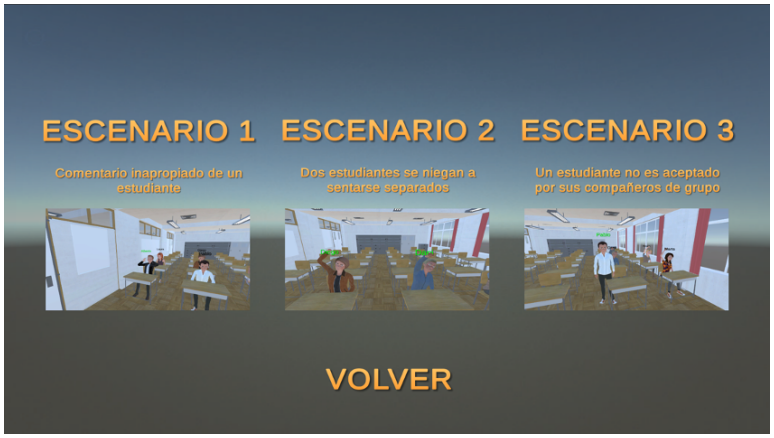

Figure 3.18: Submenu

3.2.5. Tools

3.2.5.1. *Controllers*

With the aim of building a more realistic and immersive game, its characters would react according to the events of the scenario and the player's actions.

In order to make this possible, *Animator Controllers* (Unity Documentation) from Unity were used. These allowed us to arrange and maintain a set of Animation Clips and associated Animation Transitions between them using a State Machine, as shown in Figure 3.19.

In this way, the above-mentioned animations from Adobe Mixamo are attached to each state, being able to move from one state to another by activating different parameters.

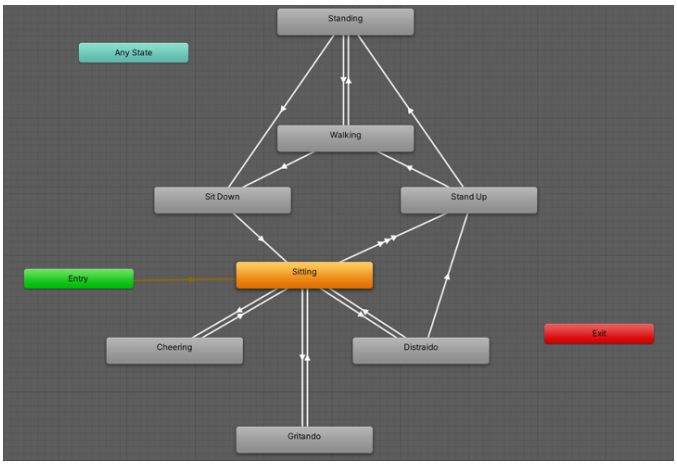

Figure 3.19: Students´ *Controller*

Each student in Unity would have their own version of this *Animation Controller* attached. By using an *Override Controller* (Unity Documentation), a custom *Animation Controller* for each character can be created, which would maintain the original structure of the State Machine but replace each specific Animation Clip associated with each state with its own, as can be seen in Figure 3.20.

Figure 3.20: Example of *Override Controller*

Therefore, thanks to these *Controllers*, we will be able to represent the different reactions of the students during each scenario, when they have to be distracted or get up from their seat to sit in another one.

3.2.5.2. *Colliders*

The *Colliders* (Unity Documentation) were helpful in spotting various events during the simulation. These Unity components surround the object to which it is attached (this can be seen in Figure 3.21) and allow us to detect physical collisions between this and other objects. For example, when the player approaches a student, thus taking one of the paths available in the scenario.

Figure 3.21: Sphere *Collider*, in green

Another example would be when a student arrives at the new seat that has been set as his/her destination, therefore changing the active State in his/her Controller and playing the sitting down animation, as shown in the following image.

Figure 3.22: Sitting down animation being played after a *Collider* collision

3.2.5.3. *NavMesh*

In order to move the students around the class, we used a Unity component called *NavMesh*. (Unity Documentation)

NavMesh is a class that can be used to do spatial queries, like pathfinding, helping to represent an area where an agent is able to move. In other words,

this component delimits the walkable surface in an area (see Figure 3.23), so the agent can detect obstacles using artificial intelligence and find a path to reach a destination.

The *NavMesh* agent is a component that will be attached to the students, in order to allow them to navigate the Unity Scene using that *NavMesh*.

For the creation of the walkable surface, it is necessary to select the scene geometry that should affect the navigation, i. e. the class floor. In addition, to avoid that the agent goes through the elements of the environment, we must specify those objects that we do not want to be walkable, the desks and the chairs in this case, by adding them a *NavMesh* Modifier that will take care of this.

However, since the students must be seated in those chairs at the beginning of the class, the *NavMesh* agent attached to them must be turned off at first, otherwise these students would be displaced to the nearest walkable surface, being seated in the middle of the corridor.

The moment we want a student to get up from his chair and walk, we must activate the agent and establish his/her destination by coordinates.

In the early development, the student would move towards the direction where the player clicked with the mouse. Subsequently, the destination is set manually depending on where we want the students to go on each scenario (like another seat).

To make it more realistic, the student would first play the animation of standing up and then a walking animation while getting to the destination, as well as a sitting animation if the student has to sit somewhere else again.

Figure 3.23: Walkable Surface of the *NavMesh*, in blue

3.2.5.4. *SoundLoudness*

For measuring the player's voice tone, we modified *SoundLoudness*, a class implemented by other students from this Faculty in their project (Algaba Aranda y Hernández Nájera-Alesón, 2019), which uses the Unity API to measure the volume of a sound source (the microphone). For this purpose, a sample file is recorded from the microphone and a normalized value is

calculated using the root mean square, with the following formula:

$$rms = \sqrt{\frac{\sum_{i=0}^{size} wavedata(i)^2}{size}}$$

Where *size* is the number of samples in the audio clip, and *wavedata* is the collection of values inside the clip that was generated. The value of *rms* is stored inside a list so that it can be used for different purposes throughout the execution of the scenario.

Thanks to this value, we can determine if the player is speaking with a higher or lower voice tone by comparing it to an adjustable threshold, as it may change depending on the microphone or the ambient noise.

With this tool we will also be able to check if the player has overreacted to the different events that occur during the scenario by comparing this noise reaction to the average of his/her own voice tone.

3.2.5.5. *KeywordRecognizer*

KeywordRecognizer is a class from the Unity core (Unity Documentation), which is used for identifying specific words from an audio input. In our case, it would be the microphone present in the virtual reality goggles worn by the player.

This class contains a dictionary that can be provided with a word or set of words along with actions to be performed, like playing different animations or sounds, when each one is recognized. By using this dictionary, we can adapt the behaviour of the students to what the player says, which is really helpful for implementing the different paths inside each scenario.

3.2.5.6. *Vokaturi*

Due to the medical situation in Spain when developing this project, the experimental phase was impossible to carry out, as mobility around the country was restricted. Therefore, we could not travel to Barcelona to test the tool with secondary-school teachers in institutes. Because of this, we decided to add a new feature instead called *Vokaturi*.

Vokaturi (Vokaturi) is a software able to recognize directly from a voice audio the emotions associated to it. In the open-source version of this tool, it can detect five different emotions, which are happiness, sadness, neutrality, anger and fear.

a. Efficiency analisis

According to the *Vokaturi* website (Vokaturi), on its open-source version, the emotions recognition has a 66.5 % of accuracy. However, this tool is

designed for English speech, while we wanted to use it for Spanish teachers. This could result in some emotions being mistaken for others.

With that in mind, we decided to analyse the accuracy of this tool, by testing it with hundreds of audio clips in English and Spanish.

Concerning the English audios, we made use of an emotional speech data set from the University of Toronto (University of Toronto, 2010), which contained 400 samples of audio clips for each emotion. These audio clips consisted in an English speaker saying a word with a different intonation for each of the emotions that *Vokaturi* could recognize.

For the Spanish audios, we used a multilingual emotional speech corpus called *EmoFilm* (EmoFilm, 2018), from which we used the Spanish ones. These audio clips were extracted from 43 films and were classified in anger, happiness, sadness and fear. However, as there were no audio clips for neutrality, we recorded those remaining ones from native Spanish speakers with the help of our directors.

For analysing all these audio clips, we modified a testing Python script included in the *Vokaturi* open-source version in order to traverse all the clips, obtaining their individual values and calculating a mean for each set of clips of a specific emotion.

We created a correlation matrix for each language (Tables 3.1 and 3.2), where in each row, the values of the recognized emotions are displayed for a specific type of set of audio clips. The strongest emotion recognized was marked in green, and the weakest in red:

	Angry	Sad	Happy	Fear	Neutral
Angry	0,237	0,008	0,430	0,206	0,119
Sad	0,005	0,238	0,326	0,348	0,083
Happy	0,134	0,010	0,634	0,076	0,146
Fear	0,050	0,003	0,673	0,253	0,020
Neutral	0,015	0,126	0,259	0,079	0,521

Table 3.1: Correlation matrix for the English audios

	Angry	Sad	Happy	Fear	Neutral
Angry	0,480	0,035	0,253	0,196	0,037
Sad	0,059	0,210	0,138	0,247	0,140
Happy	0,256	0,089	0,119	0,261	0,210
Fear	0,188	0,067	0,249	0,410	0,071
Neutral	0,022	0,213	0,066	0,121	0,578

Table 3.2: Correlation matrix for the Spanish audios

Even though some of the emotions are acceptably recognized, the accuracy of the tool is far from perfect. Furthermore, in our analysis we can see that with the Spanish audio clips, in three of the five emotions the prevailing emotion is well recognized, while in the English clips, just two of the five emotions are correct.

Taking all this into account, we decided not to give an important role to the tool when choosing between the different paths but using it as an additional feedback feature at the end of the scenario, with just an informative function.

b. Unity adaptation

As *Vokaturi* is implemented in Python, we had to adapt it to a Unity version in C#. For this purpose, we used a Python environment that used the *IronPython* library. This adaptation was carried out having another End of Degree Project as a reference. (Algaba Aranda y Hernández Nájera-Alesón, 2019)

Once we could get *Vokaturi* working in our project, we measured the emotions on the player's speech in real time and stored the values in different lists, one for each emotion. When the scenario was over, we calculated the means for each emotion.

We decided to scale those values, normalizing them by dividing each one by the biggest value. In this way, the predominant emotion would be set to 1 to represent it more clearly in the following graph.

We downloaded this graph model from another Unity Asset pack called "Radar Chart" (MvPlanet, 2015), adapted it to use the above-mentioned mean values and added the emoticons for a more visual effect. This graph was included in the feedback screen at the end of each scenario. In Figure 3.24 we can see the comparison between the original graph model and its more visual final adaptation.

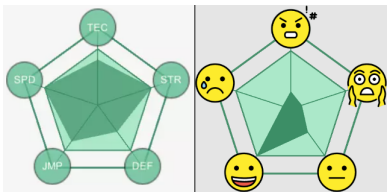

Figure 3.24: Original and modified graph model

3.2.5.7. Virtual reality adaptation

The virtual reality adaptation process for our project was carried out in the last place. We followed a guide (Oculus) to include the Oculus integration package (Oculus) into Unity to adapt the player's head movements to the

camera in the game.

However, since we did not have access to the VR goggles itself due to the medical situation, other member of the research team who had access to them tested this integration and made some final adjustments to make it work properly.

Figure 3.25: Member of the research team testing the tool

3.2.6. Audios

In this section we mention the audios we have used for our project, which are five.

In order to accurately represent events in the classroom, we needed audios to contribute to emulate the different scenarios. These audios brought some realism to our work.

To do this, we searched the Internet for audio banks, such as SoundBible (SoundBible) or SoundSnap (SoundSnap). We found what we wanted specifically in Freesound (Freesound), which is a huge collaborative database of audio snippets, samples, recordings, bleeps... released under Creative Commons licenses that allow their reuse.

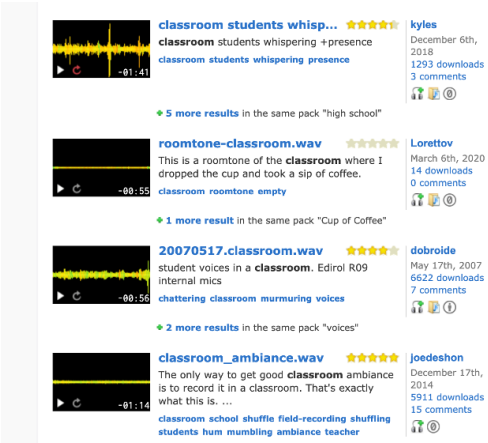

Figure 3.26: Freesound

From this website we downloaded three audios:

- An audio that played ambient sound from a classroom, composed of

whispering and conversations between students, to simulate they are distracted.

- An audio recording of students laughing, used in the first and third scenarios.
- An audio of an insult to simulate that the student insults the teacher in the first path.

Lastly, we needed two more audios that were very specific so they couldn't be found on the Internet, so we recorded them by ourselves:

- An audio of a student insulting and complaining about his classmates, used in the third scenario.
- An audio of a student explaining the reasons of his complaints to the teacher, used also in the third scenario.

3.3. Explanation of the scenarios

3.3.1. Common structure

Here we describe some of the common screens and features for all of the scenarios that we implemented.

3.3.1.1. Context screen

Every scenario begins with a context screen (Figure 3.27), which contains the background information as specified in the flowcharts, to put the player into perspective. After reading the story, the player will be able to click on "Accept" to start playing. As two of the three scenarios have a maximum reaction time, we included a variable to act as a counter for the number of seconds elapsed since the start of the scenario, which would start increasing as soon as the player clicked the "Accept" button.

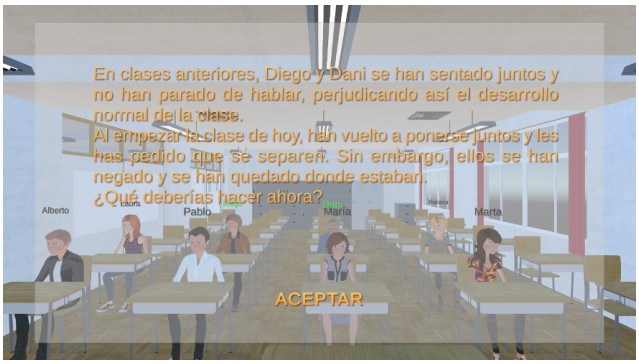

Figure 3.27: Context screen in the second scenario

3.3.1.2. TipsPanel

Another common feature of all scenarios was including a tips panel after the initial reaction from the student, that showed different options for the player as a guide, corresponding to the different paths that can be followed in each scenario. Our first approach was not to include this panel and allow the player to improvise, but after consulting the pedagogues from Barcelona this was discarded. They recommended us to include this element so that the teacher can be guided through the scenario. When the teacher makes a choice, the selected option will be highlighted in green or red (right side of Figure 3.28), depending if it is the right one or not.

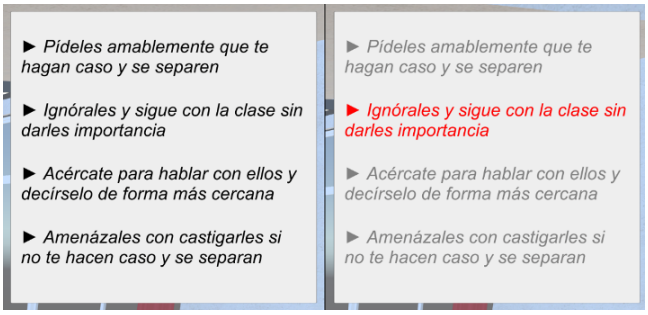

Figure 3.28: Tips panel before and after the player's choice

3.3.1.3. Feedback screen

All scenarios contained a feedback screen (Figure 3.29), which would appear when the scenario ends, with information regarding the choice made by the player according to the flowchart, and whether it was the correct path or not. The emotions graph implemented with *Vokaturi* is also shown, and three buttons which allow the player to exit the game, try again and go back to the scenario selection menu.

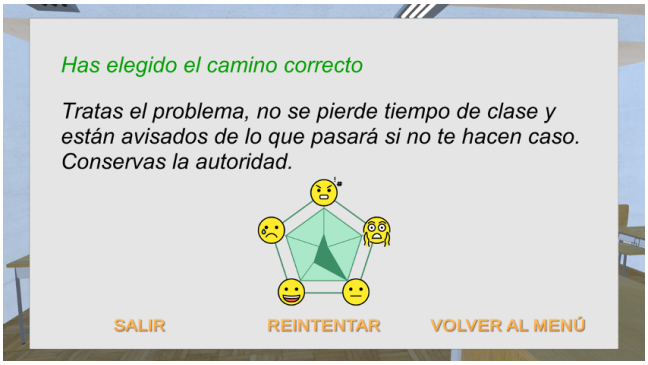

Figure 3.29: Feedback screen in the second scenario

3.3.2. First scenario: Inappropriate comment from a student

3.3.2.1. Context and problem

The first scenario exemplifies the situation where a student makes an inappropriate comment to try to get the class's attention and cause an interruption. Specifically, in our game the student insults the teacher out loud.

This problem can result in a disorder in the classroom and, if the teacher does not know how to solve it correctly, other students may follow the bad example of their classmate, thus reducing the teacher's effectiveness as a consequence and, in consequence, the effectiveness of the teacher is reduced. Therefore, the teacher has to make one of the following decisions detailed below.

3.3.2.2. Paths

- The first path is where the teacher, in a firm and determined tone, tells the student that he/she will not tolerate such comments in the classroom. This leads to a general silence of the class that then leads to background noises when the teacher resumes the explanation, so the problem is not solved correctly.

Figure 3.30: Students getting distracted after authoritative answer

- In the second path the teacher approaches the student who has said the inappropriate comment and tells him that when the class is over, they will talk about it and try to find a solution. With this gesture of the teacher the student feels attended, and the class continues. This is considered the correct path.

Figure 3.31: The teacher talking to the student calmly

- The third path is taken if the teacher decides to ignore the student and the comment he has made, because he/she thinks it is better not to give it any importance. However, this is not an appropriate way to deal with the problem, because students become distracted and background noise is heard.

Figure 3.32: Students getting distracted after the teacher ignores the problem

We have uploaded a video demonstration of this scenario that shows all of its different paths. (YouTube Video)

3.3.2.3. Scenario script

In order to represent the inappropriate comment of the conflictive student, we played an animation of that student shouting (see Figure 3.33) and the audio itself.

Figure 3.33: Conflictive student animation

To differentiate between firm and calm tone, we used the *SoundLoudness* tool (explained above) which measured the intensity of the sound.

In developing the first path our approach was as follows:

At first, we measured the voice tone after the student's commentary. However, to make sure it was more realistic, we changed it to measure the voice tone all the time from the beginning of the scenario and make two averages: the one of the audios before the comment and the one after the comment. This way we could compare the two averages and make sure that the player really does raise the voice tone.

Furthermore, just the moments in which the player really speaks were included to make the average, in order to avoid the silence between words or sentences from lowering the player's voice tone average. We accomplished this by means of an adjustable threshold that may change depending on the ambient noise of the room.

Then we also encountered special cases on stage, such as if the teacher speaks in a firm tone and then approaches the student, in which case we take the first path, or if he speaks in a low tone and approaches the student, where we would take the second path.

In addition, at the beginning we put the student's name on the word recognizer so that it would recognize whether the teacher was addressing him, but later we realized that this was not decisive, since the teacher can

say words in a strong tone that do not have to be the student's name (such as, "Shut up already").

To check if the second path was taken, we created a *Collider* around the student that would detect when the teacher approached him.

The third path would be taken when the player ignores the student; in other words, if the player has not spoken with a high tone nor approached the student after a time counter reaches its end.

In the first and third scenarios, animations of distraction would be played in all the students and a background noise audio as well.

3.3.3. Second scenario: Two students refuse to sit apart

3.3.3.1. Context and problem

In this second scenario the following situation arose: two students when they were together in previous classes did not work efficiently and talked to each other. As a result, the teacher decides to give them a warning at the beginning of the class to separate, but they do not listen to him. This situation can result in a distraction for the class and it also can damage the activity that the teacher is planning to do. With this context the scene begins from where the player must decide which decision to take by following one of the paths, each with different possibilities.

3.3.3.2. Paths

- The first path involves repeating the warning to the students in an assertive way, using words like "please" or "could you". The consequence of this action would be that the students refuse again, and the class gets distracted and makes noise.

Figure 3.34: Student getting distracted after the assertive petition

- The second path is taken if the player decides to ignore the two students and the problem that exists. By doing this, the situation is not addressed so they continue to bother the class during the lesson.

Figure 3.35: Students making noise after the teacher ignores the conflict

- In the third path the player approaches the two students to calmly and closely comment on the fact that the previous day it did not work out well for them to get together and therefore he is considering that it is not the best thing to do. This path would be the right one, since it

deals with the problem without losing any authority and in an effective way at the same time.

Figure 3.36: Students talking with the teacher

In the first instance these were the three paths that existed, but we were left wondering what would happen if the teacher addressed the two students not in an assertive way or by approaching them to talk, but in an authoritative way. As this was not contemplated in the scheme of the scenario, we decided to add a fourth path explaining precisely this possibility.

We showed it to the professionals in Barcelona so that they could explain to us in detail the consequence of carrying out the action of speaking in an authoritative way to the students. They explained to us that in this case the students would separate because they would feel intimidated by the teacher's way of addressing them, but due to this situation of tension an atmosphere of noise would be generated in the class.

Figure 3.37: Student walking to another desk

We have uploaded a video demonstration of this scenario that shows all of its different paths. (YouTube Video)

3.3.3.3. Scenario script

For the first path we used the *KeywordRecognizer* class (explained before) for identifying assertive words from audio input that, in our case, would be the microphone present in the virtual reality headset worn by the player. The action mapped to those assertive words would be the call to the FirstPath() method, that would play the distraction animations and an ambient noise from the students.

For the second path, in order to detect if the player ignores the students, we created a timer which started from zero when the scene began. Once the timer reached a specific value and the player had not done any of the other actions, the same distraction animations and ambient noise from the students would be played.

For the third one, in order to check the approach from the teacher to the students to speak to them, we detected when the teacher entered a specific area around them by means of a *Collider*. Then, the students would not make any noise for the rest of the scenario.

Finally, in the fourth path, we detected authoritative words in the same way as in the first path, or a high voice tone. For the latter, we used *SoundLoudness* (as in the previous scenario) to measure the volume of the microphone. This allowed us to detect if the player is speaking in a tone higher than a standard number of decibels. If this happened, one of the students would move to another seat with a walking animation. However, after a few

seconds, the students would start talking again, and the background noise would continue, with an ambient noise audio clip.

3.3.4. Third scenario: A student is not welcomed by his classmates

3.3.4.1. Context and problem

In the third scenario, a student who is working in a group gets up and confronts his classmates, who have been laughing at him throughout the duration of the class. He is no longer interested in working nor talking to his classmates. This poses several problems:

Firstly, the student who abandons the group will not be able to work on the task that was assigned to him, and therefore may not be able to learn certain contents of the subject that the group activity was meant to teach. This will result in him being less prepared for the course and will lower his productivity in class.

Secondly, the rest of the students in the group who were laughing at him will continue to do so once he leaves the group, creating a hostile atmosphere for the student who left the group. In addition to this, students who are laughing are not focusing in the group activity and thus will not be able to gain the required knowledge about the subject either.

In the video game, apart from an initial explanation the students are shown in two different groups of four people each. After a few seconds, one of the students gets up from his seat and an audio is played in which the student calls the rest of the group "a bunch of jerks" and refuses to continue sitting with them, standing up until the teacher decides to act. This audio was recorded from an actual secondary-school student, in order to provide a more realistic experience. Another animation is shown for the rest of the group where they cheer and a laughing audio is played, to represent the students laughing at the member who left the group.

3.3.4.2. Paths

Once the audio finishes, three different paths open up for the player:

- This path is followed if the player tells the student to sit back down. In this case, the student sits down where he was before, but the rest of the group keeps laughing at him and he doesn't work on the group task since he is not motivated.

Figure 3.38: Student sitting back down in his desk

- The player tells the student to sit on the back of the class. The student goes to the back of the class and sits on one of the empty chairs, and after a few seconds the other students that were in his group continue mocking him, without paying attention to the group activity.

Figure 3.39: Student walking to the back of the class

- The player approaches the student to ask him what's wrong. This path is followed if the player gets close to him. Then, the student explains that "his classmates are not working and are mocking him, and he refu-

ses to work with those jerks" The group activity is thus finished. This is considered the correct path since the teacher listens to the student, who feels cared for, and the continuous mocking by his classmates stops when they realize that the teacher is addressing the problem directly.

Figure 3.40: Student explaining the problem to the teacher

We have uploaded a video demonstration of this scenario that shows all of its different paths. (YouTube Video)

3.3.4.3. Scenario script

For the first path, the *KeywordRecognizer* would recognize the words like "sit" or "sit down" and then a sitting down animation would be played on the student. In addition, animations for his classmates cheering and a laughing audio clip would be played.

In the second path, the *KeywordRecognizer* is also used, so when the player says words like "back" or "end", the student would head to a seat in the back of the class by a walking animation and would sit down there with another one. However, the same animations for his classmates and the laughing audio clip would be played.

Finally, the third path would be followed if the *Collider* object attached to the player touches the student's one, so an audio clip with the explanation of the student would be played. In this case, no laughing audio clip or animation from his classmates would be played.

Chapter 4

Individual contribution

4.1. Alejandro Díaz

To begin with, we were required to research different academic articles concerning virtual and mixed reality technology applications. Each of us delved into a specific area, which in my case was medical applications, including simulators for the treatment of traumatic experiences and teaching tools for future surgeons.

Once we chose to make an educative tool, we decided to create a first draft of the classroom with free assets from the Asset Store and a few students as a starting point. I was in charge of creating this environment in Unity, importing the models and animations previously created, and placing them around a scene to create a classroom. This was useful to get used to the basic functionalities of the Unity engine.

Moreover, I implemented an initial mechanism for the students to move around the classroom using the *NavMesh* technology, which made one of the students stand up from his chair and move towards the position where the player clicked, by writing a script to allow the player to do so as well as move around the scene. For this aim, I had to divide the scene into different layers to avoid the students from climbing onto the desks and chairs.

For the student to get up from his chair and walk realistically, I added an Animation Controller that would manage its various states, making him move his legs when he walks or stands up.

When it came to use the *NavMesh* technology for moving the students in the final implementation of the scenarios, I established specific locations to direct the students to other desks when it was necessary. Also, I placed *Colliders* in the places where the student would have to sit down in order to play the corresponding animation and rotate its model to face the blackboard with a script.

During the analysis of the accuracy of *Vokaturi*, I normalized all the audio clips that we recorded, by cutting them, equaling their volume and reducing

their noise.

When writing the State of the Art section, I collected information on virtual reality and its most common applications, since our project was aimed to this technology since its inception.

Regarding the coordination with the pedagogues team from Barcelona, I discussed the initial flowcharts of the three scenarios with them through several video calls.

I wrote the introduction part of the paper we sent to EDULEARN20, summarizing the problem of current education, explaining our approach and mentioning the main objectives of the project. Also, I recorded myself presenting the tool for the video.

Lastly, I recorded the audio clips for the third scenario, in which a student gets up from his chair and talks to his classmates and to the teacher, with the help of my brother who is currently a student in secondary school. This made the scenario seem more realistic.

4.2. Álvaro López

I searched for information about tools used with educational purposes during the search of a final topic for our project. I came across interesting practical applications such as geometric construction tools based on augmented reality or story creation ones that helped children and their teachers to collaborate.

During the initial development of the project, on its first draft, I handled the integration of a word recognizer by using a Unity resource. In this way, the students would be able to raise their hand when the teacher addressed them by their names, something that was interesting as a first contact to the interaction between the teacher and the students.

In the final implementation of the scenarios, I included several words or short sentences to the *KeywordRecognizer* dictionaries that were essential to detect some of the paths that the player could take when he/she talked to the students.

In terms of the State of the Art, it was essential to clearly define what video games are and investigate how they have been used as a learning tool in all kinds of industries, including the most traditional ones, so I searched for previous approaches on this topic.

Moreover, I used this information and researched more about the problems of communication in the education field for writing the context section of the submitted EDULEARN20 paper. For the video presentation, I recorded a demo of our tool for including it and edited the final video itself.

When studying the efficiency of *Vokaturi*, I modified one of its testing scripts for conducting a performance analysis with all of the audio clips

that were available. To obtain the audios in Spanish, I found a multilingual emotional speech corpus called EmoFilm, and requested the use of their audios for our project.

Concerning the communication with the pedagogues, I was in charge of sending them the translated flowcharts of the scenarios and modifying them to obtain their final approval.

Finally, I made some modifications for unifying the animations by using a general controller and overriding it for each student. In addition, I edited some of those animations that made the models erratically move and searched for different animations for each student so they would not always move in the same way and at the same time, to provide a better experience.

4.3. Mario Bocos

I searched for other virtual reality application topics different from medicine and education. I finally found some examples like a dance training system using motion capture, a virtual storytelling system oriented to museum contexts or an application of responsive virtual humans to train law enforcement personnel in dealing with subjects that present symptoms of serious mental illness.

Furthermore, in the chapter of the State of the Art I researched in different forums and web pages about the different tools that exist today for the creation of video games, delving into the main features and components of the two most popular ones: Unity and Unreal Engine.

For the design of the different students who were part of our game with Adobe Fuse, I first researched as much as I could about the program and how it worked to explore all its possibilities. Once this was done, I created the eight models of the children based on common European student profiles, four girls and four boys. For this task I followed a refinement process until I was happy with the result. Later, I learned to export these models to *Mixamo* to be able to animate them and after that integrate them into Unity.

I implemented another of the technologies that were part of our project, that was *SoundLoudness*. I adapted the native class in order to use and store the values obtained with it. By means of the *UnityEvents* I stored those values in different places so we could compare them with the ones previously received from the player or with a fixed value allowing us to know the level of intensity of his/her voice.

Another task I did was to create the game's menu. To do this I followed a YouTube course about creating menus in Unity and I evaluated what would be the best disposition of a menu for our work. Once I decided this, I created all the buttons, texts, colors and operations of the menu itself.

In the inclusion of *Vokaturi*, I added the integration script to Unity and the emotions chart that was part of the feedback screen, by customizing one

of the pre-made charts of the asset.

I also got in contact with the team in Barcelona whenever different design decisions arose, such as adding an extra path in one of the scenarios or including a panel with the different options for the player, as well as how to manage the emotion analysis.

Besides, I wrote the conclusions section of the paper explaining the main results obtained from our project and the future work to be performed. With respect to the video presentation, I composed the script which Alejandro would later use to record himself.

4.4. Collaborative work

As a preparation for working with Unity, a game engine which we had never used before, we took an online course in Udemy, which consisted in the creation of a First-Person Shooter video game. This proved to be helpful for us since it showed us the basic notions of using Unity, and some characteristics of first-person video games that we implemented in our game, such as moving the camera or the player around.

The first step in our project was to decide the topic that we were interested in. To this aim, we had several meetings with our directors during a "divergent phase", where we discussed possible applications of a virtual reality video game. Figure 4.1 shows the results of a brainstorming session in which we wrote down possible ideas in post-it notes.

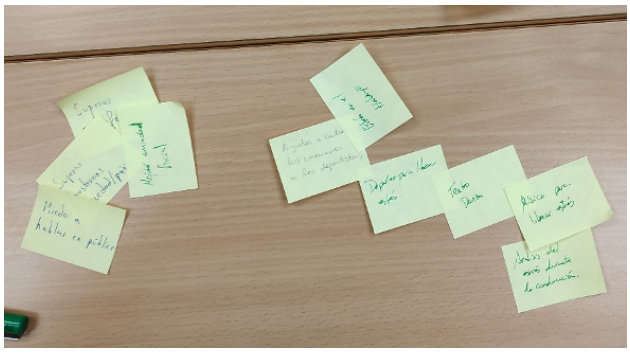

Figure 4.1: Results of the brainstorming session

When our project partners from Barcelona sent us the three flowcharts for the scenarios, we took care of adapting them to something that we could implement in Unity. Thus, we made a translation between the context and actions in the scenarios and the components in Unity, coming up with three new flowcharts that were approved by the educators.

With the help from our directors, we searched for reports about the current situation of teacher training in Spain, which we reflected in the State

of the art section.

Concerning the implementation of the game, all of us were involved in most of the parts such as the context and feedback screens, as well as gathering all the different technologies used to make the scenarios work in a consistent way.

Apart from that, we made some extra modifications such as adding a fourth path to the second scenario or showing a tips panel to the user with every path available, which were implemented after consulting the experts from Barcelona.

Before adding *Vokaturi* to our project, when carrying out an analysis on its accuracy, we needed seventy-five audios in Spanish with a neutral tone, since they were missing from the corpus we downloaded. To obtain them, each of us and our directors recorded several male and female audio clips, which were then edited adjusting their duration and removing any background noise.

Another task that we performed in common was the addition of Oculus Integration to our project. We found documentation regarding the integration of this asset to Unity and its configuration for our type of project. Since we did not have access to the virtual reality goggles and controllers due to the closure of our faculty, we asked one of the members of the research team to test this new functionality by herself.

Regarding the EDULEARN20 paper, we all wrote the abstract, as it was the first step in the acceptance process of our tool at the congress. Moreover, we completed the development section and refined the other ones before sending the paper.

Chapter 5

Conclusions and future work

In this section, we will go through the main conclusions that we have obtained from our work, as well as cover the main objectives from the beginning of the project and propose possible future work to further enhance our application.

5.1. Conclusions

For many secondary-school teachers, handling conflictive situations inside a class proves to be a real challenge, since they usually never receive any training before confronting a real situation with real students. The teacher's behavior regarding oral communication plays a crucial role in developing a positive relationship with a student (Campbell et al., 2004), since an educator is a reference in the educational and personal development of the pupils (S Yoon, 2002), especially at early ages.

The communication process between a teacher and a group of students can be seen as that of a speaker and his/her audience. There are clear similarities between them, in particular that the speaker must talk about a certain subject and keep the attention of the audience by giving an interesting speech.

The effect of a virtual audience in a speaker has proved to be a useful tool in several previous works, helping to alleviate the fear of public speaking. (El-Yamri et al., 2019) With this in mind, we developed this tool to make it easier for future teachers to adapt to the events that take place in the real world.

To do so, we added to the game many features that we extracted from real situations to build a highly immersive environment, like the set of audios or the animations used in the scenarios. Furthermore, we allowed a realistic communication system, such as detecting the teacher's position concerning the students or spotting different emotions depending on the teacher's speech.

5.1.1. Accomplished objectives

Looking back at the objectives that we were considering in the beginning of the project, we have accomplished the following:

- We have developed a virtual reality video game with several functionalities, such as voice and emotion recognition, that depicts a secondary-school classroom in a precise way
- We have integrated different conflictive behaviors that students can show inside a real classroom, as well as different responses a teacher could have and their consequences.
- We have created a tool that will be useful for students of master's degree in teacher training, and for secondary-school teachers, to help them deal with the difficult situations that may arise in a classroom, providing them with feedback based on their actions.

In our view, these objectives meet what was expected from our project and, as stated in Section 2.4.1.2.b, will serve as a starting point for the Didascalia (RTI2018-096401-A-I00) project.

5.1.2. Main conclusions

The first conclusion is that realistic scenarios are essential to strengthen the players´ (preservice teachers) immersion and to minimize the impact when they arrive in a real classroom. Besides, this tool, as any simulator, will permit the players to make mistakes within a virtual classroom with no risks, something essential to improve their communication skills and raise their self-confidence. In addition, players will be informed about their performance and will be given a detailed feedback.

We found that the Unity game engine was a helpful software to create this simulator, with a high level of accuracy and concreteness. It allowed us to model the students in every way and create very detailed conflictive situations, with different behaviors for each of them. This makes Unity a valuable tool for creating virtual environments in the form of a video game, especially for serious games.

In addition, modelling disruptive behavior of students based on pedagogical analysis makes the virtual students very realistic. The study of the disciplinary reports from a real institute has helped us a great deal when building the environment. Moreover, the combination of the artificial intelligence (included in the development process) and the immersive features allow us to create an accurate reflection of the pedagogues model.

Also, working alongside a team of people unfamiliar with computer engineering and software development, pedagogues in this case, showed us the process of communicating with other specialists and combining knowledges

of different fields in order to create a final product of high quality. This experience will serve us in the future as it is something that software developers have to deal with frequently.

Finally, we find the use of virtual reality and AI, a novel and exciting path to solving the problem that many educators face when they start teaching. Besides, a videogame (an interactive approach) makes it more engaging and accessible to users than traditional methods of learning, as seen in several cases. (Manero et al., 2015) Furthermore, the pedagogical part of the team reaction was positive after testing the video game, since they considered that the scenarios were correctly represented. With that being said, we consider this project a promising approach to be included in the program of master's degrees in teacher training.

Our tool could be helpful for this kind of training programs, as a practical experience to complement the current methods of teaching. Moreover, it could be used as a reference for building highly immersive simulators concerning any topic, by reusing some of its technologies such as scripts, *NavMesh* or *KeywordRecognizer*.

5.2. Future work

Due to the impossibility of carrying out the experimental phase in this project, the next step would be to test the application in a real institute with actual lecturers, in order to refine the tool and prove its efficiency. By recording the reactions from teachers who play the video game as well as their feedback and impressions about the tool, we can obtain data to investigate the most common obstacles that teachers find when dealing with conflicts in classrooms.

Also, something that we were not able to finally include as we did not have access to the goggles, was the adaptation of the virtual reality controllers, in order to make the player move around the class and navigate through the menu by using them.

As far as we have implemented only three scenarios, this initial project will serve as a starting point for a more complex application, which can be enhanced by other researchers or members of the Didascalia group. Furthermore, it can be a reference for other students who plan to develop similar projects.

There would be several choices to improve the efficiency of this tool. First, more scenarios with more elaborate interactions could be developed, such as having more students involved or several conflicts occurring at the same time. Secondly, the technologies used in the project such as *Vokaturi* or the *KeywordRecognizer* could be upgraded, for instance by using a more efficient emotion detection tool or a sentence recognizer instead of a word one.

Appendices

Acceptance Letter

This is the Acceptance Letter received confirming that our abstract was accepted at EDULEARN20, so we could follow the process by submitting the paper.

25th of June, 2020

ABSTRACT ACCEPTANCE LETTER

This is a confirmation that the abstract entitled:

"A VR GAME TO IMPROVE COMMUNICATION SKILLS IN SECONDARY-SCHOOL TEACHERS"

Author(s): Mario Bocos-Corredor, Alejandro Diaz-Nieto, Alvaro Lopez-Garcia, Alejandro Romero-Hernandez, Ibis Alvarez, Borja Manero

has been accepted as VIRTUAL presentation at EDULEARN20.

Name of event: EDULEARN20 (12th annual International Conference on Education and New Learning Technologies)
Dates: 6th-7th of July, 2020
Organising entity: IATED

EDULEARN20 Local Organising Committee

EDULEARN20 Paper

The following pages show the paper that we submitted to EDULEARN20, once our abstract was accepted.

A VR GAME TO IMPROVE COMMUNICATION SKILLS IN SECONDARY-SCHOOL TEACHERS

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Abstract

According to the reports of training practices from future secondary-school teachers, there are significant shortcomings in the communication skills required to properly manage a class. Despite the existence of modules related to communication in the educational masters of teaching staff, there is no real learning in this area, and students (the future teachers) express their fear when it comes to dealing with a class.

Currently, virtual reality is present in different fields, such as medicine, engineering, humanities, etc. Its characteristics (in particular the one concerning the creation of a safe environment, its ubiquity, and its high immersion capacity) turn it into an ideal technology for training communication skills. In parallel, in the last ten years, videogames have proven their effectiveness as learning tools, alone or combined with other pedagogical strategies.

For these reasons, we consider the following hypothesis: Virtual reality in combination with videogames is, on the one hand, an effective environment for simulating realistic situations related to secondary education, and, on the other, an ideal environment to practice and learn communication skills for the classroom.

Taking this into account, we have created a virtual environment that serves as a training tool for future secondary-school teachers, to improve their communication skills and get used to a real class. It simulates a secondary-school class with students and works as a videogame. The virtual students work by simulating real students' behaviors in the classroom.

Future teachers start the game in front of the class as in most secondary schools. The tool sets the game background, offering the complete context, actions, or previous behaviors (i.e., two students have been fighting all over the previous week). After, the user has to react as in a real situation, managing complicated situations. Our videogame analyses in real-time the user's behavior (voice tone, the distance between the user and the problematic student or students and detection of assertive or negative vocabulary) and reacts through the students themselves, i.e., offering realistic behavior to the user's actions.

We are optimistic about the possibilities of our tool on the teachers' training since it avoids the expensive and logistical complicated real environments practices. The experts consulted agree on the added value that this tool can offer to practices in real schools. The videogame offers the perfect environment to learn and understand how to manage stressful situations through effective communication before facing real students.

Keywords: Videogames, education, virtual reality, teaching, serious games.

1 INTRODUCTION

The lack of communication skills training in many developed countries is a fact. European Union has warned of the need to take action to enhance Europeans oral communication skills. Teachers are not an exception. [1] Around the world, teachers are not adequately trained, and their lack of communication skills is notorious. [2] As a result, many of them leave their jobs in their first year due to frustration and other mental health problems [3]. Particularly in Spain, there is no systematic treatment of communication issues, and most teachers do not receive specific training in oral expression. [4]

Several approaches are trying to solve this aspect inside the master's degrees in teacher training [5] [6]. However, the results obtained show that the development of these skills has significant shortcomings [7] as there is no specific subject to improve communication skills. Instead, basic notions are taught in other subjects, which are insufficient, and practical sessions on this topic are short and given by teachers who don't have full knowledge of the issue.

On the other hand, advances in technology have much contributed and in different ways to society, ranging from the treatment of mental health problems such as post-traumatic stress disorder [8], social anxiety [9] or phobias [10], to the training of workers [11], in addition to new ways of teaching students in different disciplines such as theatre [12], dance [13] or geometry [14]. One of the advances that have contributed most to making this possible is virtual reality, which makes it possible to create very immersive environments. [15]

We wanted to find a way to help teachers face a classroom full of students who would behave unexpectedly. Our proposal is a virtual reality-based videogame. By developing a simulator with a virtual classroom full of students whose behavior can be scripted, we could provide teachers with different situations to see how they would react and give them feedback based on their actions.

Our approach would help teachers to give an actual lecture and know which actions would have a better outcome for the class, as well as let them feel more relaxed and reduce their stress level. So, our videogame/simulator is addressed to future teachers who would want to experience how teaching a class is like.

1.1 Objectives

Our main goals throughout the process were:

- To simulate a secondary education classroom with virtual students with realistic disruptive behaviors.
- To develop a videogame which accurately reflects a real-life classroom with students who have disruptive behaviors in the classroom.
- To provide teachers with a helpful tool which can help them prepare for managing classroom conflicts.
- To allow future researchers to gather data on what would be the reactions from the teachers to the different situations presented to them, analyze this data and come up with a summary of the most common reactions to discuss with teachers.

2 CONTEXT

In this section we describe some of the most relevant topics in our project, providing a background to the motivations and tools used for developing this work.

2.1 Education

According to the ANPE (Spanish acronym of Independent union, at the service of public education teachers) syndicate, conflict in the classrooms occurs at younger and younger ages. [16] Moreover, the reports of training practices from future secondary-school teachers say that there are significant shortcomings in the communication skills required to manage a class properly. Despite the existence of modules related to communication in the educational masters of teaching staff, there is no real learning in this area, and students (the future teachers) express their fear when it comes to dealing with a class. [17]

The teacher must know how to use conflict skilfully, regulate it, and treat it positively. Effective classroom management depends on the teacher's ability in using an appropriate tone and encouraging the learners to cooperate in the classroom. For this purpose, mediation and negotiation are strongly advised [18]. Both are complementary ways of managing conflicts, with mediation being one way of carrying out the negotiation. These terms are especially important for mitigating the factors that cause violence in education.

There are two basic types of negotiation: collaborative and competitive [19]. In collaborative negotiations, both parts look for an adequate solution to their demands. This way of negotiation should prevail in schools, since there is an affective bond and equality.

Conversely, competitive negotiation is based on personal positioning without putting oneself in the place of the other part. This approach should be used with caution because it can promote more serious conflicts than the first ones.

With our tool, we are going to try to identify how this negotiation is approached and give feedback to the users to improve their skills when it comes to dealing with conflicts.

2.2 Serious games

Literature usually define serious games as games used for purposes other than mere entertainment. The purpose of this type of games is creating learning environments that allow us to experiment with real-world problems. In this way, serious games help us explore different solutions to problems posed in real situations and discover the information and knowledge that would help to be able to intervene without fear of error. The lack of real-life consequences facilitates the decision-making process, teaching us the optimal choices in those situations, and helping the development of different skills. [20] Thus, videogames are a potent tool that makes possible the creation of virtual environments that would be impossible in the real world for reasons of safety, cost, time, etc. [21]

Some industries realize the effectiveness of serious games (called simulators), including military, education, civil aviation or healthcare. [21] For instance, there are several tools companies use to train their employees in new skills and resources, such as basic techniques for managing different situations and give them feedback so they can adapt their responses appropriately. [11]

2.3 Virtual reality applied to communication skills

Virtual reality places the user inside a 3D artificial world in which he/she can interact with the environment as if it was real, allowing the creation of realistic scenarios for various purposes, such as education, entertainment, or social science.

These characteristics have made it possible to apply virtual reality to communication skills [22] by building virtual environments with an audience that reacts to the player's verbal and non-verbal language. Examples of this include its use for treating the fear of public speaking [23] or as a communicative medium between patients and therapists [24].

3 DEVELOPMENT PHASE

Here we cover the whole process of creating and developing the videogame, following the instructions provided by education professionals.

3.1 Design of scenarios

This section explains the process to obtain the scenarios, from an initial idea to a full description of the implementation details with Unity.

3.1.1 Selection criteria

The analysis was carried out by professionals from the *Universitat Autònoma de Barcelona*, who selected the scenarios based on a first approximation to the records of an institute known by one of the experts that participate in the project. The knowledge of the context was here a weight factor.

The content of the reports was insufficient for the design of the scenarios. Since there was a lack of background information that is not normally recorded on them.

The creation of the scenarios mainly based on the behavior of the students. Among the most frequent incidents that the pedagogues found, we selected two. One puts the core of the conflict on the teacher's communication with a student, while in the other one, the conflict involves more students. In addition, a third situation was created that also focuses on a conflict involving several students.

Since it is required to design interactive communicative situations (teacher-student), complementary contents were proposed to design teacher's answers.

3.1.2 Proposed scenarios

Three scenarios with a similar scheme were given to us by the educators. Each of them began with the description of an initial conflict, where the teacher had to make a choice. Depending on the action taken by the teacher, the user can follow different paths, each one with positive or negative consequences for the class. Afterward, feedback would be provided to the players, informing them about their performance.

As shown in Figure 1, we describe every situation in the form of a flowchart, one for each scenario, containing all the relevant information.

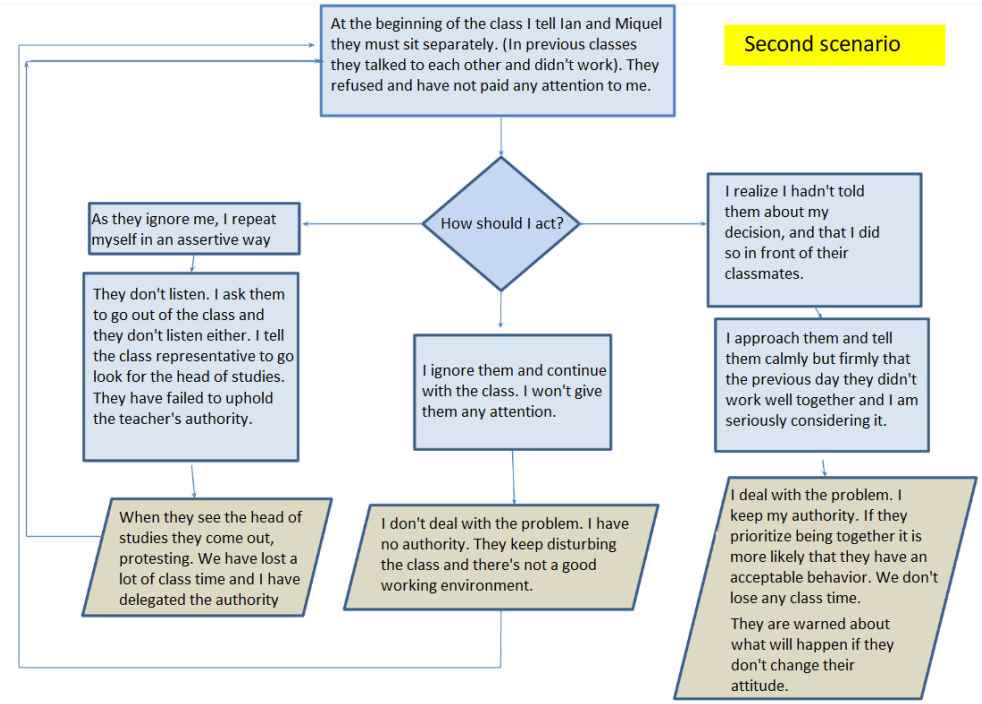

Figure 1. Second scenario as proposed.

3.1.3 Adaptation of the scenarios

The next step towards building the videogame was to adapt these diagrams to make them suitable for their implementation. To that aim, we created a new flowchart for each scenario that contains, for each possible situation, a description of how it would be represented in the implementation.

As example, in the right path from Figure 1, it is specified that the teacher approaches the students. The software we used to develop the videogame (Unity 3D) contains features that allow monitoring if an object (in this case, the player) is within a specific range of another (the students). Thus, in the new diagram, this procedure is described as “Detect that the teacher approaches the students”, to ease the implementation phase.

Furthermore, in the second scenario (see Figure 2), we decided that it could be interesting to detect if the teacher speaks in a high tone to the students, despite it not being part of the three original parts. Therefore, our pedagogues advised adding a fourth path that considers this case, marked in green, to provide a better experience to the player.

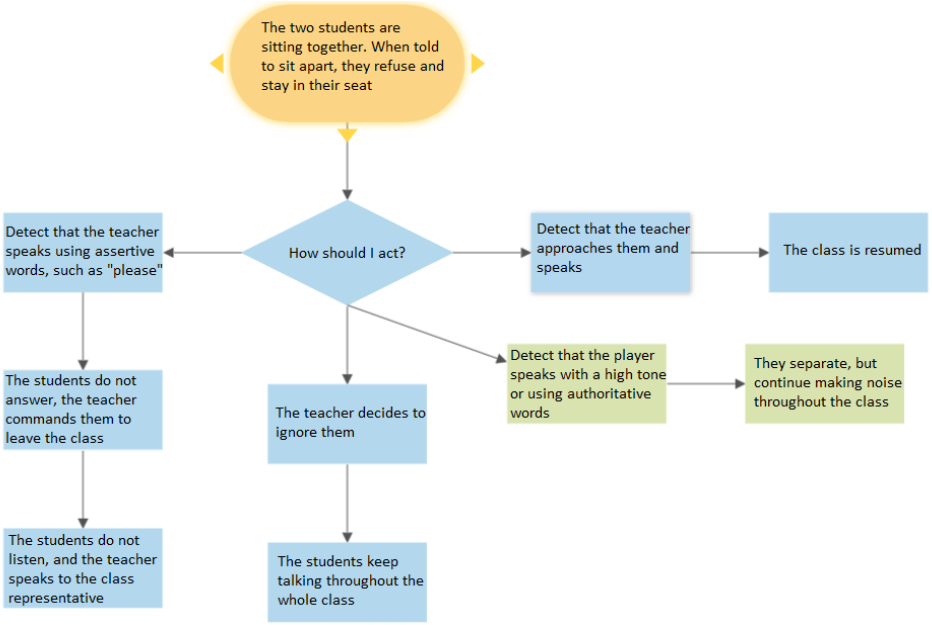

Figure 2. Second scenario adapted.

3.2 Implementation

In this part, we detailed the components that were part of the implementation of the videogame, covering from the objects to the scripts.

3.2.1 Environment

When designing the setting, we took a typical Spanish secondary-school classroom as a reference. Its main components were the desks and chairs, the blackboard, and a platform for the teacher with a lectern. To this end, we decided to use an asset pack from the *Unity Asset Store* named “Classroom”, which included all the necessary elements.

We decided to include thirty seats for students since that is the maximum number of students per classroom according to Spanish law [25]. Another design decision was to place the teacher in a platform, higher than the students, a common feature of classrooms that allows the teacher to see and be seen by all the students. Initially, the teacher is facing the students, as the scenarios require him/her to be able to observe their behavior.

Figure 3. Simulated an actual secondary-school classroom.

3.2.2 Students

Next, we created models of students using *Adobe Fuse* [26]. This program allowed the creation of 3D objects in a fast and straightforward way, customizing their aspect and characteristics. Apart from that, we assigned to each student a label with a name to help the player to be able to address them. Labels are important for the communication between teachers and students since students can benefit from perceiving that instructors know their names [27].

We decided to include a total of eight students. We found that eight students were high enough to represent all the proposed scenarios, and low enough so that it was not overwhelming for the teacher. Four of the students were boys, and four were girls, since according to the Spanish Ministry of Education, 51% of all secondary-school students are men, and 49% are women [28]. All of them were Caucasian, since that is the most common race among European schools, with just 9% of international students in Spanish classrooms [28].

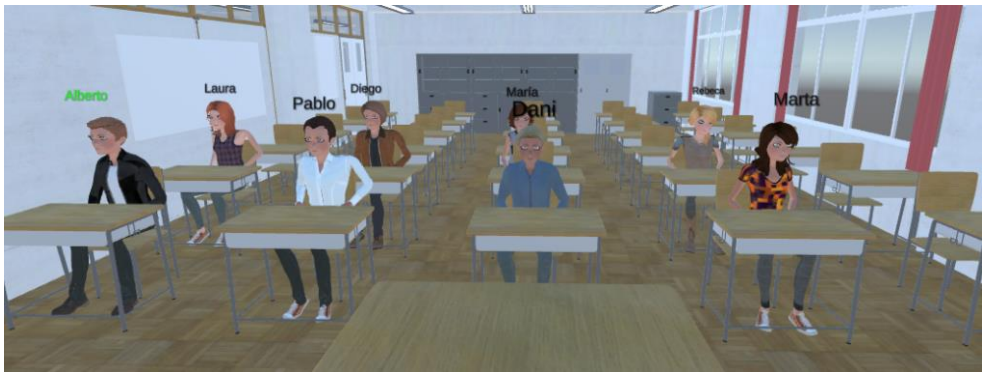

Figure 4. Students from the teacher's view.

3.2.3 Students behaviour

After creating all of the students, we used *Adobe Mixamo* [29], a tool used for animating the previous model. In this manner, we were able to represent in a precise way common students' disruptive behaviors in the classroom, such as sitting, cheering, laughing, or getting distracted.

To explain the behavior of the students, we go over the three scenarios, going into detail in the second one:

Each scenario starts with a screen with text describing its context, to put the player in the situation. In the second scenario, the teacher told two students to sit apart, but they didn't listen. When the player clicks on the Accept button, the game shows the class from the teachers' point of view. The platform in front of the students, with the name of the two conflictive ones highlighted in green. From that point on, the teacher can move around the class and speak.

A timer starts, and the player must now follow one of the displayed options. Each option is the starting point for a path and will have consequences for the class.

In this case, we follow the first path when the teacher speaks using assertive words. For this purpose, we used a word recognizer called *KeywordRecognizer* [30], a class from the Unity core, which is used for identifying specific words from audio input, that in our case, would be the microphone present in the virtual reality headset worn by the player. Said class contains a dictionary that maps a word or set of words to action inside the program. By using this dictionary, we can adapt the students' behavior to what the player says. For instance, we added the word "punish" to the dictionary and the action of playing an animation in which one of the students moves to a different seat, out of fear of being grounded.

In the second path for this scenario, the player ignores the students and continues the class. The game detects it when the timer reaches a specific value, and the player has not done any of the other actions. Consequently, we trigger the laughing animation and sounds of student laughter.

In the third one, the player approaches the students to speak to them. We detect when the teacher enters a specific area around them. Then, the students feel calmer, and they don't make any noise for the rest of the scenario, allowing for the class to continue. The game considers it the best path possible, as the teacher keeps his/her authority and does not let the students interrupt the class.

Finally, we take the last case if the player speaks using authoritative words, detected in the same way as the first path, or with a high voice tone. For the latter, we used *SoundLoudness* [31], which uses the Unity API to measure the volume of a sound source (the microphone). For this purpose, we record a sample file from the microphone, and we calculate a normalized value between zero and one using the root mean square. This value is compared to a threshold, which may change depending on the microphone or the ambient noise. That comparison allows us to detect if the player is speaking in a tone higher than a certain number of decibels. As a result, one of the students moves to another seat since the teacher's voice has frightened them. However, after a few seconds, the students start talking again, and the background noise continues, with an ambient noise audio clip.

We also apply this feature in the first scenario, where a student makes an inappropriate comment about the teacher. In this case, we record the sound from the teacher before the comment, and then we compare to his/her initial reaction after it, to check if she overreacts.

To move the student around the class, we used a Unity component called *NavMesh*, which represents the area where an agent (an object assigned to the students) can move. In other words, this component delimits the walkable surface in an area, so the agent can detect obstacles using AI (desks or other students) and find a path to reach a destination. We also use this component in the third scenario, where the teacher may tell the student to sit on the back of the class.

Another of the tools that we implemented was *Vokaturi* [32], a library that, receiving an audio track, analyses and classifies the speech into 5 basic emotions: neutrality, happiness, anger, sadness, and fear. These emotions can have a value from zero to ten, indicating their level of intensity. It helped us to analyse the emotions of the player, in addition to the other parameters, to be able to take everything into account when choosing the right path. For example, if the emotion of anger is recognized, the game takes the path of the authoritative words.

When the scenario finishes, the players receive feedback, highlighting positive aspects, depending on their decisions. Each scenario has a best path, where the teacher deals with the problem without losing his/her authority and without losing control.

The record of the player's actions (preservice teacher) as well as the content of the feedback received will be the essential inputs to further develop teacher training in classroom conflict management.

We made use of every tool described to adjust the scenarios to the flowcharts that were provided and subsequently adapted.

4 CONCLUSIONS

For many secondary-school teachers, handling conflictive situations inside a class proves to be a real challenge, since they usually never receive any training before confronting a real situation with real students. The teacher's behavior regarding oral communication plays a crucial role in developing a positive relationship with a student. [33]

The effect of a virtual audience in a speaker has proved to be a useful tool in previous works, helping to alleviate the fear of public speaking. [34] With this in mind, we developed this tool to make it easier for future teachers to adapt to the events that take place in the real world. To do so, we added to the game many features that we extracted from real situations to build a highly immersive environment. Further, we allowed a realistic communication system, such as detecting the teacher's position concerning the students, or spotting different emotions depending on the teacher's speech.

The first conclusion is that realistic scenarios are essential to strengthen the players' (preservice teachers) immersion and to minimize the impact when they arrive in a real classroom. Besides, this tool, as any simulator, will permit the players to make mistakes (within a virtual classroom with no risks), something essential to improve their communication skills.

Secondly, modelling student's disruptive behavior based on pedagogical analysis makes the virtual students very realistic. The combination of the AI (included in the development process) and the animations allow us to create an accurate reflection of the pedagogues' model.

Finally, we find the use of virtual reality and artificial intelligence, a novel and exciting path to solving the problem that many educators face when they start teaching. Besides, a videogame (an interactive approach) makes it more engaging and more accessible to future teachers than traditional methods of learning.

Furthermore, the pedagogical part of the team reaction was positive after testing the videogame. We consider it a promising approach to be included in the program of master’s degrees in teacher training.

5 FUTURE WORK

The next step to take is to experiment with the application, to refine the tool and prove its efficiency. By recording the reactions from teachers who play the videogame as well as their feedback and impressions about the tool, we can obtain data to investigate the most common obstacles that teachers find when dealing with conflicts.

As far as we have implemented only three scenarios, this initial project will serve as a starting point. We should develop more scenarios with more complex interactions to improve the efficiency of this tool.

ACKNOWLEDGEMENTS

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