Using MMOL Platforms for collaborative educational tasks

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ABSTRACT

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Dedication

To Hugo and Estela, they are my main wellspring for continued insight, growth, true joy, and a gentler heart.

With so much controversy in

the air, it's understandable that

only a few teachers and schools

make the attempt.

David Perkins

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Abstract

Massively Multiuser On-line Learning (MMOL) platforms, often called "virtual learning worlds", constitute a still unexplored context for communication-enhanced learning, where synchronous and asynchronous communication skills in an explicit social setting enhance the potential of effective collaboration. In this thesis, we report on three experimental studies of collaborative educational tasks in an MMOL setting.

The effort of first study concentrates on the analysis of group's role-play to improve group's skills. This experience was carried out by 21 graduate students enrolled in university courses in technology-mediated teaching and learning. In this experience, the students' group undertook a collaborative task about Learning Object evaluation using the mainstream Learning Object Review Instrument (LORI), which is based on a Convergent Participation Model (CPM). The same experience was carried out using a conventional LCMS (Learning Content Management System) platform with the aim of contrasting the outcomes and interaction patterns in the two settings. This study makes use of Social Network Analysis (SNA) measures to describe the interactions between tutors and learners. By dwelling on the advantages of

immersive environments, SNA indexes revealed that these interactions were rather dense and that student participation was rather broad-based in the case of the MMOL.

The second study is about teachers' role-play in order to increase teacher's skills in psycho-pedagogical support for high school students. We put forward a proposal to encourage the use of 3D scenarios where teachers can improve their teaching-pedagogical skills for situations of cultural and ethical concerns that require a high level contextualization. We organize the study and improvement of those skills related to diversity, equity and inclusion in education. This study is centered on teachers and students of secondary education enrolled at the Castilla La Mancha (Spain) high schools. The ultimate aim is to demonstrate whether the MMOL platforms can improve such skills training teachers in virtual reality simulations. Study makes use of Descriptive Statistics and Standards Performance Continuum (SPC)[1] test (Doherty, Hilberg, Epaloose, and Tharp, 2002; Hilberg, Doherty, Epaloose, and Tharp, 2004), to define use of diverse standards in a teaching improvement process and to highlight the importance of using multiple standards simultaneously in real or virtual simulation-based learning activities. Results suggest that MMOL platforms contribute a more effective teachers' control of school problematic situations and cases.

The third study proposes the establishment of a learner's role-play to improve learner's skills. Foreign languages' learning is the focus

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[1] SPC is available at
http://gse.berkeley.edu/research/credearchive/standards/spac_chart.shtml

of the report because can serve as an appropriate context to analyze self-directed learning strategies and the culture of Lifelong Learning. The goal of this research is the creation of an integrated technology platform that enables the creation, development and deployment of contents and activities for teaching Spanish in an educational virtual world. Such environment promotes an immersive, creative and collaborative experience in the process of learning Spanish. In order to assess the validity and reliability of this technology we used the Technology Acceptance Model (TAM). The ultimate intention is to measure the acceptability of MMOL platforms for foreign languages learning.

All studies were carried out using a prototype of MMOL platforms built around an interactive and collaborative 3D space. In the first two above-mentioned cases, the collaborative space was called "*MadriPolis*". In the latter case, we built ad hoc space called SLRoute Island.

The results suggest that MMOL platforms can be used in collaborative tasks as a means to enhance both tutor/learner interaction patterns and the strength of the group's relationship. Furthermore, MMOL platforms can create a stimulating atmosphere around a collaborative creative learning process, also because this technology builds on a pre-existing common interest by users in the multi-user 3D videogame culture.

Resumen

Las plataformas MMOL (Massively Multiuser On-line Learning), también conocidas como "mundos educativos virtuales" constituyen un área todavía inexplorada en el contexto de los aprendizajes mediados por la tecnología en los que las capacidades de comunicación síncrona en un entorno social explícito mejoran la colaboración efectiva entre los participantes. En esta tesis, damos cuenta de tres experimentos de trabajo colaborativo llevados a cabo mediante el uso de plataformas MMOL

El primer estudio analiza las prácticas grupales de role-play como mecanismo de mejora de las capacidades del grupo. Esta experiencia fue llevada a cabo por 21 graduados matriculados en diferentes cursos a distancia. Este grupo de estudiantes realizó una tarea colaborativa como es la evaluación de objetos de aprendizaje utilizando para ello el formulario LORI (Learning Object Review Instrument) y el modelo participativo convergente (CPM, Convergent Participation Model). La misma experiencia se realizó utilizando una plataforma de formación a distancia convencional o LCMS (Learning Content Management System) al objeto de contrastar los resultados y los

patrones de interacción identificables en ambas plataformas. En este estudio se ha hecho uso del análisis de redes sociales o SNA (Social Network Analysis) para describir las interacciones entre tutores y alumnos Tomando en consideración las ventajas de los entornos inmersivos, los indicadores del análisis de redes sociales revelan que estas interacciones parecen ser más compactas y la participación de los estudiantes es más frecuente en el caso de las plataformas MMOL.

El segundo estudio trata sobre las actividades de role-play aplicadas a los profesores con el fin de mejorar sus capacidades psico-pedagógicas para ayudar a los estudiantes de Secundaria. El trabajo propuesto pretende fomentar el uso de escenarios 3D en los que los profesores puedan mejorar sus destrezas cuando se trata de cuestiones éticas y culturales que requieren un alto grado de conceptualización. El estudio está dirigido a mejorar específicamente las siguientes problemáticas: multi-culturalidad, educación en valores y atención a la diversidad. Se ha llevado a cabo con profesores de secundaria de institutos castellano-manchegos. El objetivo último de estas experiencias es demostrar si las plataformas MMOL pueden mejorar tales capacidades entrenando a los profesores en simuladores de realidad virtual. Este estudio hace uso del test Standards Performance Continuum (SPC) (Doherty, Hilberg, Epaloose, and Tharp, 2002; Hilberg, Doherty, Epaloose, and Tharp, 2004) para determinar la utilización de diversos estándares en un proceso de mejora de la enseñanza y al propio tiempo señalar la importancia de utilizar simultáneamente varios de estos estándares en las actividades de aprendizaje basadas en la simulación de hechos en la realidad o en mundos virtuales. Los resultados indican que se puede conseguir un control más eficiente de las situaciones y casos problemáticos del entorno escolar cuando se utilizan las plataformas MMOL.

El tercer caso de estudio propone el desarrollo de actividades de role-play con estudiantes al objeto de mejorar sus capacidades. Se centra en el aprendizaje de idiomas ya que es el contexto adecuado para analizar las estrategias de autoaprendizaje y de formación continua. El objetivo de esta investigación es la creación de plataforma tecnológica integrada que permita la creación, desarrollo y puesta en funcionamiento de contenidos y actividades para la enseñanza del español en un mundo virtual educativo. Tal entorno proporciona una experiencia inmersiva, creativa y colaborativa en el proceso de aprendizaje del español. Al objeto de evaluar la validez y fiabilidad de esta tecnología se ha hecho uso del Modelo de Aceptación de la Tecnología (*Technology Acceptance Model*, TAM). El objetivo último es determinar el grado de aceptación de las plataformas MMOL para propósitos educativo.

Todos estos estudios se llevaron a cabo utilizando prototipos de plataformas MMOL construidas en torno a un espacio colaborativo 3D. En los dos primeros casos, el espacio colaborativo se llama "*MadriPolis*". Para el último estudio se construyó un espacio *ad hoc* denominado Isla SLRoute.

Los resultado de estas investigaciones sugieren que las plataformas MMOL pueden ser utilizadas en tareas colaborativas y cooperativas como una forma de mejorar tanto los patrones de interacción profesor-alumno, como las fortalezas de las relaciones entre los miembros del grupo. Además, las plataformas MMOL pueden favorecer una atmósfera típica de un proceso de aprendizaje creativo y colaborativo, lo cual también se debe a que esta tecnología se construye sobre aquellos intereses comunes prexistentes en aquellos usuarios de la cultura basada en los video juegos 3D multiusuario.

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Chapter 1. *Introduction. Problem & proposal.*

1.1 Motivation.

This study began as a development of our research into effective techniques for learning and teaching using educational virtual worlds to incorporate newer work and experiences in educational practice and delivery. As a consequence, the thesis presented herein is focused on discussing educational virtual worlds capabilities to train group's and personal's social skills in a media-rich, collaborative and immersive environment. We are interested in producing knowledge from a multi-case educational perspective that goes beyond the single case. Furthermore, we have theoretical assumptions that participation, concerns, co-participants, contexts and structures of practices have significant influence on couplings between learners' skills improvement and the use of educational virtual worlds or MMOL platforms. That makes it relevant and interesting to be able to explore variables in cases and compare the findings across different cases. This should make it possible to produce knowledge about the significance of use MMOL platforms in students' everyday life. Adopting a multiple-case study approach may provide an adequate research strategy for addressing the potential impact of MMOL platform on training learner's skills.

In this sense, the appearance of *metaverses* or virtual environments is a novel phenomenon in the modern culture. 3D learning environments, unlike traditional 2D environments, provide students with the possibility to explore worlds and have realistic stages with a clear educational purpose. These new environments serve as support for the effective development of skills by simulating situations, events or problems. Virtual worlds on three-dimensional environments of virtual, mixed or augmented reality have been widely used in various areas of knowledge and professional activities and have allowed a clear improvement of abilities and skills of those who participate in this kind of experiences. Training of pilots, members of armed forces, brokers, chemicals, doctors in different specialties, etc. by using virtual worlds and simulations is understood to be necessary for both their initial training and their improvement in professional practice. Virtual worlds represent a process for concepts' training and knowledge construction in general. But also these worlds strengthen new contexts implementation to allow learners subject matter knowledge outside methodological context where take place. Compared to conventional science, cutting-edge science is increasingly based on simulation paradigm over virtual worlds, rather than experimentation of real phenomena and facts. We have coined the term "Massively Multi-user Online Learning (MMOL) platforms" to describe 3D issues on the subject of technology in education. The generic features that these tools can provide to education can be summarized in the following points:

- Each teacher and student is an active entity, becoming the architect of his/her own learning and his/her own experience.
- Allow experiences revision by specialists and experts that directly or indirectly could contribute to an improvement process.
- Enable educational patterns definition and implementation to guide teachers in both experiences and practice teaching.
- Support experimental and conjectural learning.
- Provide an open learning environment based on real models.
- High level of interactivity.
- Help to teach certain skills and competencies.
- Teachers and students can understand phenomena's characteristics, how to control them or what to do under different circumstances.
- Promote exciting or entertaining situations that encourage informal learning.
- Store results and experiences in order to analyze and review guidelines for action.

Many authors have developed theoretical formulations on the use of simulations and virtual reality environments about improving the skills and abilities (Axelrod, 2005; McGaghi, Pugh and Wayne, 2008;

Issenberg, McGaghie, Petrusa, Lee Gordon and Scalese, 2005; Aldrich, 2005; Lorenzo, Sicilia and Alonso, 2012).

It is also interesting to consider initiatives undertaken in some countries especially relevant in educational field, as is the case of Finland. One of these examples is called "Future School of Finland"[2], which will let institutions to design and implement schools that address the needs of 21st century learners through a combination of basic skills, learning management skills, media literature skills, and life skills. The focus is on students' ability to learn and the functional entities that support this. The learning and education environment benefits through access to 3D environments, electronic tools and learning materials, but just as important is that learning becomes meaningful because it is tied to real world requirements, tailored to the specifications of each student. It is worth noting that in this example, there is an emphasis on a broad base of community involvement, including parents. The educational framework is based on project-based learning, inquiry learning, phenomenon and observations from fellow learners, and creative problem solving.

From the field of Cognitive Psychology, Neuroscience and Neuropsychology, it follows that learning would greatly benefit by moving from the memorization of facts to the acquisition of cognitive skills like thinking, learning, and reasoning. Spatial memory is the part of memory responsible for recording information about one's spatial

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[2] http://edu.ouka.fi/~koulunet/futus/

context and its spatial orientation. The current “show-and-tell” teaching methods do not take into account the strengths and weaknesses of the crucially important working memory and they under-utilized the visual-spatial sketchpad. This is where educational virtual worlds can play a powerful role in learning, as it is inherently based on 3D contexts and can exploit the characteristics of the most powerful components of the brain (Newman, Caplan, Kirschen, Korolev, Sekuler, and Kahana, 2007).

1.2 Overview

Whilst improved pedagogy and not technology should drive the development of education, technology is starting to provide a wide range of options and improvements to current learning materials through the application of interactive digital multimedia. We need, however, to bear in mind that sound guidelines should steer the creation of technology-enhanced learning environments. For example, learning material must be structured, meaningful and coherent, the environment should involve learners in a variety of enquiries, the environment should provide a variety of quality hands-on experiences which encourage learners to choose, explore, etc. In this sense MMOL platforms can make an outstanding contribution.

The key to achieving goals is the collaborative and cooperative learning, as well as Computer-Supported Collaborative Learning (CSCL). The broadest definition of 'collaborative learning' describes situations in which two or more people learn or attempt to learn something together (Dillenbourg, 1999). When learning takes place via social interaction using a computer or through the Internet is usually called CSCL. The common thread that runs through all of our experiences is the use of 3D technology and Internet-based solutions.

Collaboration and cooperation are sometimes used as synonymous terms, while other authors use these terms distinctively according the degree of division of labor. In cooperation, partners split the work, solve sub-tasks individually and then assemble the partial results into the final output. In collaboration, partners do the work 'together' (Dillenbourg, 1999). Our experiences use both collaborative and cooperative approach because we consider that a rich educational context could benefit from both.

Thus, we understand that apart from the term definition, a relevant question as regards collaboration or cooperation concerns the persons' interactions. The first question is that interactions are crucial for interchange knowledge, that is, how these interactions influence the peers' cognitive processes. For example, let us assume that two researchers must evaluate the value of two learning objects. If they cooperate, they will each evaluate one learning object. Their processes are independent: one might assess item by item, while the other uses the general aspect of the object (as a digital content). They will interact after a while in order to make their estimations consistent with each other; but these interactions come after the individual production of partial solutions, and hence each opinion will only influence them if these solutions have to be revised. If the two researchers interact during the assessment process, one research might say "Let's assess from item 1", thereby leading his partner to evaluate learning object by items instead of globally. In both situations, interactions exist and could be complementary.

Another question is to address the moment in which interaction takes place. Normally, collaboration implies synchronous communication, while cooperation is often associated with asynchronous communication. The experiences offered in this thesis primarily use synchronous time because if one participant has for instance to regulate another participant, both must work synchronously and hence interact synchronously. This issue became salient in MMOL platforms in which communication tools are often characterized as synchronous. It does not mean that asynchronous interactions might not exist. For example, SLRoute experience enables students to learn Spanish when needed, at any time, wherever they wish and in the most suitable way. Interactive in-world group sessions, usually led by a Spanish teacher, can be combined with in-world training sessions or self-learning conducted by a bot or a Non Playable Character (NPC) using artificial intelligence (AI).

This applies when dealing with the concept of negotiation. A main difference between collaborative interactions and a hierarchical situation is that one partner will not impose his view on the sole basis of his authority, but will - to some extent - argue for his standpoint, justify, negotiate, attempt to convince. Hence, the structure of collaborative dialogue is expected to be more complex than, for instance, tutoring dialogues (Dillenbourg, 1999). One relevant example of this on-going dialogue with students' groups is our experience about diversity, equity and inclusion in education. For example, the 3D educational context contributes to explain social and educational interaction as it relates to persons relationships and structure of the group to its environment and operation, analyze leadership styles and determine their effectiveness in learning situations; identify methods in resolving group problems; describe the impact of culture on students behavior; and analyze team dynamics, team building strategies, and cultural diversity. This is made possible by a collaborative dialogue.

1.3 History.

The ancestors of today's contemporary educational virtual worlds can be traced even before the World Wide Web in the late seventies with the appearance of the first Multi User Dungeon (MUD). The MUD is considered to be the first form of a virtual world, a text-based multi-user interactive environment (Bartle, 1996). There are two main groups of MUDs.

The first one is an adventure based MUD that is a fantasy game world. It is usually built around an age old culture with objectives of solving problems, slaying monsters or dragons and discovering little treasures.

The second type of MUDs is a relatively open virtual game world where the participants interact with the things in the world that open their imagination. They can create, control and invent objects and components in much more social environments. The users interact with each other in various ways, including building objects together and architecture of interest. Because of their significant feature of building, they are known as the MUDs of the object oriented variety or MOOs. In their development in the past, numerous MOOs expanded their socially creative function to an educative, experimental and a professionally oriented one. Their appearance is very significant in the history of computer-based learning. In other words, MOOs adjusted and transformed the gaming technology for professional and educational use. (Haynes and Holmevil, 2004).

MUDs and MOOS place in the history of electronic games is quite important for game studies, but also for several others research disciplines as well (Bartle, 2010). Because of the fact that in the past few decades the online user-to-user interaction can be digitally documented and later on analyzed, scientific research on psychological, social, cultural, linguistic, strategically and behavioral became available . This was a huge step for science in terms of localizing research subjects and topics with an open access and a worldwide audience. Besides, studies were conducted for improvement of the MUD and their expansion to other frontiers.

From a genre perspective, MUD ignited an explosive appearance of online adventure based, fantasy and role-playing multi-user environments forming a new genre of electronic games known as massively multiplayer online games MMOG (Massively Multiplayer Online Game) and MMORPG (Massively Multiplayer Online Role-Playing Game). Furthermore, because of the multi-applicative nature of the platform, many other types were born (Doppke, Heimberger and Wolf, 1998; Bell, 2008; Damer, 2008; Spence, 2008).

At the end of 1980s appear new contexts as player-extendable place for social interaction in spaces that resembled rooms, houses, hotels and castles. Similar little MUDs appeared in the following few years, developing a feature that was quite important for the future virtual world systems – player programmability. With this feature, players were able to build new objects, new rooms and also write programs that can affect the MUDs greatly. Out of these little MUDs was the first MOO. Pavel Curtis developed it further, and in 1990 he wrote LambdaMOO with enhanced the server technology. In the next seven years, it became a popular place for players from all over the world (Haynes and Holmevil, 2004).

The potential of the initial MOO system was recognized and developed even more in other directions (Bartle, 2010). In 1992 Amy Bruckman at the MIT media lab adapted this platform for media researchers, thus elevating the significance of MOOs to a professional scientific tool. The MediaMOO quickly became a meeting place for thousands of curios visitors and academics from various backgrounds, who connected professionally through the platform. Because of their nature and conceptual resemblance to the modern ones, some game theorists consider the MOOs to be the first generation of educational virtual worlds. Their interaction dynamic was similar to classroom interaction with tools that aimed to give the users a variety of activities.

The educational virtual worlds from the 1990s already belonged to the latest generations of generic virtual worlds. The concept, interface and mechanics were almost identical to the current Second Life and Active Worlds. The interface and navigation function in the equal manner, combining communication tools like a type of chat system and graphic emotional expressions with destination map, transportation system and viewpoints. The content of each one is appropriate to its study field and the target group spans from the earliest ages to adult users. Open access and virtual traveling to different in-worlds is already possible which assures cultural, social and academic exchange. The first virtual world that had a 2D interface that resembled a 3D perspective was WebWorld created by Ron Britvich in 1994. Its users could move around in a virtual space, interact via a chat system and also build objects. Tens of thousands were using the platform until it was reformed to AlphaWorlds and in 1997 became Active Worlds, the biggest online world of the time. In 1999 Active Worlds launched an in-world educational program called AWEDU (Active Worlds Educational Universe), intended for students, educators and pedagogical researchers for knowledge exchange in virtual classrooms and virtual tours.

From the 2000s many 3D Virtual worlds were designed with an educational purpose for educational institutions and informal self-explorative learning. Based on these designs, several researches were carried out in order to establish the foundations of this new approach (Barab, Hay, Barnett and Squire, 2001; Klopfer, Squire and Jenkins, 2003; Gee, 2007, 2009; Gee and Levine, 2009; Barab, Gresalfi, Ingram-Noble, Jameson, Hickey and Akram, 2009; Steinkuehler, 2008). With their help students could experientially learn about for example the solar system, navigating in the virtual universe and access to its elements, science and painting as well as use them for simulations and tests for a certain issue.

1.4 Conceptual framework and literature review

One of the first questions raised in our research is to establish the conceptual framework which is required to determinate theoretical guidance and bases of educational virtual worlds and their instructional implications. This analysis was carried out on the basis of existing studies and related work from a variety of angles that includes: education virtual world's issues, collaborative learning analysis, simulations and on-line role-play questions, and instructional design problems.

E-learning and virtual worlds' options have grown in number and now provide teachers and institutions with a range of choices in learning and teaching design. For instance, options include choosing a fully educational immersive experience or a partial option combining both immersive and face-to-face learning experiences, known as mixed reality learning. Educational virtual worlds could be a well-established strategy in e-learning and can be used to assist learners' learning upon a range of curriculum issues. According to Gardner et al. (2011) there is a great deal of interest in applying immersive virtual worlds to teaching and learning. Much of this interest has been caused by the success of commercial platforms such as the World of Warcraft (WoW)[3] for on-line gaming, and Second Life[4] for on-line social networking and e-commerce. These environments have a high level of realism and associated levels of engagement, as well as supporting and encouraging social interaction. The most commonly virtual world used by educators seems to be Second Life, though several others are aimed at this sector, including Open Wonderland[5], Metaplace[6] or ActiveWorlds[7] (Gardner, Gánem-Gutiérrez, Scott, Horan and Callaghan, 2011). Our research is based on the idea that educational virtual world must be vendor- and technology-agnostic and student-centered. Anyway, as discussed below, virtual world server is just one more piece of MMOL platforms. The aim is to study that more immersive, participative and flexible educational settings, combined with individual support for students, tended to be conducive to achieve better social skills.

Several detailed comparative studies about the use of virtual worlds in Secondary and Higher education were carried out in order to reach a broad understanding of the current state of art (Magee, 2006; Hew and Cheung, 2010; Wang and Lockee, 2010; Kim, Lee and Thomas, 2012). Some scholars ask questions like how virtual worlds are used by students and teachers or what research topics have been conducted on virtual worlds in teaching and learning. Findings show that educational

[3] http://www.worldofwarcraft.com/
[4] http://www.secondlife.com/
[5] http://www.openwonderland.org/
[6] http://www.metaplace.com/
[7] http://www.activeworlds.com/

virtual worlds may be utilized for the uses like communication spaces, context simulation and experiential issues. These researches have been most frequently carried out in areas like media arts and health and environment (Hew and Cheung, 2010). Other comparative studies focus attention on integrating 3D virtual worlds into distance education and how these studies were conducted. These studies conclude that 3D virtual worlds might be an appropriate medium for distance education, but more studies are required with specific attention to the inclusion of wider ranges of courses and participants, the addressing of social presence and collaborative learning, and the employment of more quantitative data methods (Wang and Lockee, 2010). Therefore, in the way we propose, multi-case study research based on a cross-case analysis, studies with significant number of participants, and school-based experiences focus on educational agents (teachers, learners and groups) and their skills, all need further study.

1.4.1 Educational virtual world's issues.

The focus of many studies about educational virtual worlds seems to be the creativity of the learning design in particular scenarios or topics. For example, Mzoughi et al. have applied virtual learning worlds to teaching and learning optics (Mzoughi, Davis, Foley, Morris and Gilbert, 2007). Merchant has discussed how these technologies can be used to enhance literacy teaching (Merchant, 2010). Wojciechowski et al. have proposed a virtual and augmented reality system for informal education, like museums (Wojciechowski, Walczak, White and Cellary, 2004). The armed forces, industry, medicine, commerce, organizational governance, design, political science, architecture and libraries are other areas where virtual world teaching can substitute in-the-field experiences (Rose, Attree, Brooks, Parslow, Penn and Ambihaipahan, 2000; Bouras and Tsiatsos, 2006; Bray and Konsynski, 2007; Brenton, Hernandez, Bello, Strutton, Firth and Darzi, 2007; Wilson, 2008; Gerald and Antonacci, 2009; Hewitt, Spencer, Mirliss and Twal, 2009; Smith, 2010; Clarke, 2012). Most educational virtual worlds allow advanced content manipulation, uploading, creating and sharing 3D objects and other media contents. As it is noted in (Bessière, Ellis, & Kellogg, 2009), content can be 'objects, places, activities' or any valuable information or experience. These immersive contexts allow creating complex interactive content and use it collaboratively for various purposes. Virtual worlds allow learning communities to create content and leave traces of their activities that become part of the shared repertoire of the community through the process of reification (Wenger, 1998). A growing number of institutions have started using educational virtual worlds for presentations and promotions, conferencing and other purposes. In this way promotion of the organization is one of the primary reasons for non-profits establishing their presence in virtual worlds (Bettger, 2008).

However, despite the great diversity of educational designs and the impressive examples of the technological possibilities, the research has yet to offer sufficient practical suggestions on how to apply virtual worlds in school-based educational settings (Lee and Kim, 2010). When teachers, institutions or instructional designer attempt to use virtual worlds in education to facilitate interaction and leaners' self-direction, they might have difficulty in searching for literature that offers prescriptive instructional methods. Our research aims to provide direction, offers additional and practical experiences to guide instructional work and tries to reduce the lack of how to apply virtual worlds to improve teachers' and learners' skills in an immersive environment. Consequently, one of our goals has been to measure and increase users' satisfaction in the use of 3D learning environments.

1.4.2 Collaborative and cooperative learning analysis.

One of the reasons why educational virtual worlds has been constantly increasing during the recent years is the potential and possibility of such environments for supporting CSCL work, as discussed in several studies (Snowdon, Churchill and Munro, 2001; Bouras and Tsiatsos, 2006; Atkins, 2009; Girvan and Savage, 2010).

Another important reason is an opportunity for participants to interact in a way that conveys a sense of presence (Park, Hwang, & Choi, 2009), lacking in other media (Kelton, 2007). Users are represented by avatars and act in a shared 3D space that gives them awareness of each other's actions. Communication is usually presented in the form of gestures, text-based chat and allows using educational virtual worlds for meetings, performances and role-playing (Sant, 2009). These opportunities result in a number of benefits for establishing and supporting learning communities (Bronack et al., 2008).

Some scholars have provided immersive learning experiences for understanding concepts, exploring and learning, as well as socializing or playing serious games (Bailenson et al. 2008; Jacobson, Kim, Miao, Shen and Chavez, 2010; Robbins and Butler, 2009; Schrank, 2009; Minocha and Reeves, 2010; Petraku, 2010; Susaeta, Jimenez, Nussbaum, Gajardo, Andreu and Villalta, 2010). Several others have reconsidered how we learn in these new contexts (De Freitas and Neumann, 2009; Bers and Chau, 2010; Wrzesien and Alcañiz, 2010; De Freitas, Rebolledo-Méndez, Liarokapis, Magoulas and Poulovassilis, 2010; Girvan and Savage, 2010; Kartiko, Kavakli and Cheng, 2010; O'Connor, 2010). Other researchers had pointed out instructors' roles and described how they change in the transition from in-person classrooms to teaching online and, in particular, to virtual learning environments (Berge, 2008a). Bronack et al. have examined the tutor's role as a member of a community of practice in which everyone is a potential instructor (Bronack, Sanders, Cheney, Riedl, Tashner and Matzen, 2008). Lorenzo et al. have analyzed how MMOL platforms can improve teacher skills in areas like cultural diversity, values education and students' diversity (Lorenzo, Padrino, Sicilia and Sánchez, 2011). Livingstone has discussed the benefits of integrated collaborative virtual environments for teaching and learning (Livingstone et al., 2008). In a similar direction, Livingstone and Kemp have investigated the use of Massively Multiplayer Online (MMO) games as a learning tool in a traditional college setting (Livingstone and Kemp, 2006). De Freitas has studied virtual worlds as more complex social environments where the tutor's challenges rest with the design and delivery of immersive activities and experiences (De Freitas et al. 2010). Dickey has concluded that these virtual contexts have considerable potential for facilitating collaborations, community and experimental learning (Dickey, 2005).

Despite the great opportunities of educational virtual worlds for situational and collaborative training, exploration of scenarios, and visualization, it is necessary a much broader segment of the academic community in utilizing, and developing further these technologies (Djorgovski, Hut, McMillan, Vesperini, Knop, Farr and Graham, 2010) and the body of knowledge on educational studies in educational virtual worlds has not developed enough (Campbell and Jones, 2008). Therefore, the main goals of this thesis related to collaborative and cooperative tasks are: first – to investigate the possibilities of educational virtual worlds for learning communities, second – to explore how to support interconnected aspects of educational agents in an integral virtual environment for teachers', learners' and group's skill improvement, and three – to measure users' satisfaction when 3D environment is used. Therefore, in spite of the increasing number of reports available, the use of virtual learning worlds for a specific cooperative and collaborative task, like collaborative evaluation, has still not been studied from a comparative perspective.

1.4.3 Simulation and on-line role-play questions.

Simulation and role-play need an improved environment with reference to interaction and communication capabilities. According to Kim and Thomas (Kim and Thomas, 2012) educational virtual worlds provide a more advanced form of interaction than other online educational tools, like forums, instant messaging, etc. By in-world interaction, users may experience true simulations of real world conditions. This has profound implications for learning environments. Unlike instant messaging, virtual worlds enable users to have many-to-many communications as well as verbal and non-verbal communications through avatars (Robbins, 2007). Verbal communications are synchronous based on text, while non-verbal communications use flicks or facial expressions of avatars to convey a particular meaning (Robbins, 2007). Text-based interaction is complemented when users exist as avatars in a virtual environment leading to a more active and interactive experience in virtual worlds than more common instant messaging tools. Although in-worlds interactions need to evolve in order to respond swiftly and effectively to ever-changing context. Our research is based on the use of communication-enhanced context, like voice and video chats. Despite of the existence of numerous studies that support text-based and conventional interactions are necessary to study what happens when voice and video is used in immersive and collaborative experiences.

A good deal of studies about simulations and role-play indicate that the active learning that occurs during a simulation-based educational experience has a much longer-term effect on attitude than traditional classroom models (DeKanter, 2005). Simulations and role-play have been used in several different areas, including in Social Sciences, and how simulations can serve the purpose of prediction, proof and even scientific discovery (Axelrod, 2005). Comparative studies of Issenberg, Pugh, Wayne, McGaghie, Petrusa, Lee Gordon, Scalese, etc. about using virtual worlds and simulations in medicine (McGaghi, Pugh and Wayne, 2008; Issenberg, McGaghie, Petrusa, Lee Gordon and Scalese, 2005). Clark Aldrich's proposals contained in his book "Learning by Doing: A Comprehensive Guide to Simulations, Computer Games, and Pedagogy in e-Learning and Other Educational Experiences", on how to choose appropriate simulations for the right situation (Aldrich, 2005). Bouras et al. have studied virtual worlds as a place for many people with different roles (Bouras, Triglianos and Tsiatsos, 2008). Liberman and Linn argued that computer based simulations may be particularly useful in helping students to build self-directed learning strategies, and in assisting students to apply knowledge in realistic context (Liberman and Linn, 1991). According to O'Neil and Fisher, the effects of simulations have the potential to facilitate learning in five ways: (a) enhance thinking skills (b) facilitate metacognition (c) improve knowledge and skills, (d) improve attitudes, and (d) promote motivation (O'Neil and Fisher, 2004). Simulations are used in many educational settings as a mechanism to train personnel and increase effectiveness. In any case, by examining the trends in literature and implementation of educational simulation, this review will provide the framework for the identification of lacks in current studies and directions of simulation-based education. Medical, business, military or educational simulations have all developed their own models for developing learning experiences. All of these disciplines come with their own philosophical perspectives on the nature of knowledge, learning and instructional design. Thus further experiences are necessary in order to lay the foundations of the learning over time. In this sense our research focuses on modeling and simulating specific facts from a holistic and comparative understanding of a three-agent process: learner, teacher and group, and we likewise investigate the evaluation of virtual world experiences' instructional effectiveness and its validity and reliability. According to Kim et al. the educational application of virtual worlds needs specification, verification and diversity (Kim et al., 2012).

1.4.4 Instructional design problems.

As a theoretical basis, the focus on designing for learning through the use of educational virtual worlds, simulations and role plays draws on the work of a range of constructionist, constructivist and connectivist authors including Vygotsky (1978), Brown, Collins and Duguid (1989), Papert (1991), Duffy and Cunningham (1997) and more recently Siemens (2005, 2008). An on-line 3D learning implementation, empowers students to construct their own meanings, to test the multiple perspectives of a social environment, to construct their own and realistic learning context, to draw on the power of synchronous interactions to facilitate connections with resources and each other, and to use those social networks to polish their mental models.

In this sense, different scholars have studied these issues from different points of view: (a) reduce barriers between students, tutors and instructors (Kemp and Livingstone, 2006), (b) facility collaboration on 3D artifacts or other content in order to become increasingly important in modern working and learning processes (Kemp and Livingstone, 2006), (c) design an inclusive, open and user-centered virtual place

(Bouras, Triglianos and Tsiatsos, 2008), (d) develop a feeling of belong to a community in order to create a virtual social space and to improve learning outcomes (De Lucia, Francese, Passero, and Tortora, 2008), (e) feel part of a virtual environment (*presence*) to suspension of disbelief and increase motivation and productivity (Bouras and Tsiatsos, 2006), (f) interact asynchronously and synchronously as virtual worlds allow students to view and access the educational resources, even when synchronous time is not necessary. (Petraku, 2010), (g) increase social awareness and improve knowledge transfer and understanding through multiple communication channels both verbal and non-verbal communication (De Lucia et al., 2008; So and Brush, 2006), (h) augment user's representation and awareness, using avatars along with gestures and additional icons attached to the avatar. (Bouras and Tsiatsos, 2006), (i) design to reduce the amount of extraneous load of the users (Bouras, Triglianos and Tsiatsos, 2008).

Many of the difficulties with the use of simulations and role-play in 3D learning have to do with the instructional design aspects more than how educators do the simulation design. Although the use of simulations on educational virtual world has been well established, there is still a considerable amount of work that must occur to help teachers understand if the simulation models underlying them are valid (Ramasundaram, Grunwald, Mangeot, Comerford, & Bliss, 2004; Lorenzo et al., 2012). In contrast, our thesis proposes experimental instructional designs in order to control possible variables and compares experimental groups with control groups to prove the hypothesis and causation. As related below, instructional designs proposed herein are based on educational frameworks broadly examined in scholarly journal literature. Our proposal is that these frameworks can be adapted to implement educational experiences on educational virtual worlds.

As a consequence, despite of the existence of numerous studies that support suitability of virtual worlds in educational issues, simulations, collaborative and cooperative tasks and their results from a multi-case perspective are still few and far between in the literature.

1.5 Problem addressed.

Technology is a stimulus for "digital era" fellows. These new individuals called "Millenials" (Oblinger & Oblinger, 2005) or "digital natives", (Prensky, 2001) or "Y-ers" or "Y Generation" (Krause, Hartley, James and McInnis, 2005) or "Net Generation" (Tapscott, Lowy and Ticoll, 1998) or "Homo Zappiens" (Veen and Vrakking, 2006). This entire people share a common global culture defined less by age than by their experience growing up immersed in digital technology. This experience affects their interaction with information technologies and information itself, as well as the ways they relate with one another, other people and institutions.

It is clear that engagement with digital technologies is transforming learning, socializing and communication among people who are able to access and use them. For these learners, activities like collaboration, role-playing, remixing, content generation and sharing are important aspects of daily life. Many of these activities are 'friendshipdriven', serving to maintain relationships with people already known offline. Others are 'interest-driven', allowing persons to develop expertise in specialized skill sets such as animation or blogging. In either context, the casual, frequent use of new media contributes significantly to the development of technological, social and curricular skills. Electronic media also provide an opportunity for intense, self-directed, interest-driven study.

The benefits of far-reaching digital technologies extend beyond learning to promoting creativity and activism. Learners are using these technologies to express themselves through videos, images, video games, socio-computational systems, etc. They are creating inspiring political movements, watchdog groups and new modes of organizing that combine the online and the offline. They teach one another as they build out into the global cyber environment. As a result, cooperative learning structures within the virtual and real world could produce an effective institutional learning experience.

On the specific and important issue of collaborative learning and Computer-Supported Collaborative Learning (CSCL), scale is a very relevant question of case studies. How many learners? How much time? For instance, most empirical research on the effectiveness of collaborative learning was concerned with a small scale: of two to five subjects collaborating for one hour or so. At the opposite end of this scale, CSCL is often applied to situations in which dozens of people follow a course over one year. In any case, the scale must be determinate for the observer, who selects the most appropriate unit of analysis. In computational models, the choice is rather open since there is no 'natural' notion of agent as there is in Psychology. A so-called 'agent' can be any functional unit inside the system. Sometimes, a single rule is labeled as an agent, sometimes it corresponds to an entire rule base or a predefined behavior. Some systems include a few agents with elaborated skills while others include a large number of agents with elementary skills. The former perform meaningful computation; have goals, knowledge and even mutual representation. The latter are not viewed as intelligent agents, their interactions are not planned, but interesting phenomena hopefully emerge after a large number of interaction cycles (Dillenbourg, 1999). Our case studies try where possible to include these agents, as in the case of SLRoute Island.

Young learners are who demand these highly interactive and collaborative environments, such as MMOL platforms. The European students become part of this group. Unfortunately we do not have studies that quantify the learners' percentage with 3D tools abilities. Experience shows that young people enter in these worlds like a part of their informal initiatory learning. We should inquire whether the education system is providing resources for a relevant use of this technology in learning at all levels.

Furthermore, electronic media in general, and 3D worlds in particular, can provide useful and meaningful solutions for the greatest difficulties encountered today by the education system - at all its levels -. Educational institutions may help future students improve their "immersion" and social abilities through 3D technology and virtual worlds. This is why defining conceptual framework is extremely important, in order to ensure a successful adoption of new educational technology by educational establishments.

Consequentially, this thesis presents a comprehensive study of how to bring virtual 3D worlds to the attention of educators, who can ultimately integrate them in their education practices/system, in particular to collaborative and cooperative tasks. We report on three experimental studies of collaborative educational tasks on MMOL platforms, as unexplored context for simulation-based learning, where synchronous and asynchronous communication skills in an explicit social setting enhance the potential of effective collaboration and CSCL. Furthermore, we study the use of proved statistical tools and tests to measure user's satisfaction in the use of 3D learning environments.

1.6 Research Agenda

The thesis research agenda is situated at the intersection of academic discourses on educational virtual worlds and practical solutions implementation for teaching and learning in these worlds. Our research began considering the conceptual framework which is required for determinate theoretical guidance and bases of virtual worlds and their instructional implications. It is surprising, therefore, that the metaphor that has been guiding developers of cyberspace is the document metaphor—the same one that dominated user interface design when computers were used primarily to access information, rather than to inhabit the information space itself. The document metaphor sees information as separate from the people who use it and from the environment in which it is used: a commodity that can be encapsulated and distributed by mechanical or electronic means, and used by anyone, anywhere, without affecting the quality of the activity. While this approach has been successful in making informational contents accessible, it fails to account for the confluence of the information and the place-specific process of accessing and using it: a process replete with socially- and culturally-rich experiences derived from contextualization (Kalay, 2004). For this reason, an important motivation of our studies is to get away from this notion of document metaphor and provide the scientific foundations to evolve towards multi-user 3D metaphor.

Once the conceptual framework was established, we developed the three functional prototypes for the experiments. First, the *MadriPolis* world was built like collaborative and cooperative space to put in practice the group and teachers role-play experiments. After that, *SLRoute Island* was implemented to conduct the learners' role-play research. Finally, these case studies were carried out and conclusions were drawn with respect to these experiments.

1.7 Research Objectives

The overall objective of the research presented herein is to offer the opportunity to discuss modalities of working within the new context and of making optimum use of 3D educational resources at their disposal to enhance teamwork and coherence of a collaborative approach. To be more precise, we have summarized the main design and research objectives in the following list

a) Design educational context on MMOL platforms to develop meaningful experiences to compare different modalities of using 3D virtual worlds in education, assessing their effectiveness.
b) Gain a better understanding of the use of virtual world for educational purposes.
c) Measure and increase users' satisfaction in comparison to other models (e.g. 2D learning environments, face-to-face, etc.).
d) Provide a new framework to experiment and test situations that are difficult or expensive to replicate in real settings.

1.8 Method overview

Educational institutions have long ago understood the importance of providing a place for students to be engaged and supported in their learning activities, such as classrooms, schoolyards, libraries, gymnasium and sports centers, concert halls, recording studios, laboratories, etc. Traditional learning has focused on the distribution of learning materials such as textbooks and scientific literature, the presentation of lectures, followed by assignments and examinations. While many of these approaches have been transferred to virtual learning environments, such as Learning Content Management

Systems (LCMS), the development of virtual places for learning is not as well developed. Operationally, 'place' is the setting that transforms mere spaces and activities into unique sociocultural events: the coming together of people to the same location, at the same time, for the purpose of participating in a common, authentic, one-of-a-kind, memorable activity (Kalay, 2004). This is one of the thesis main goals, so MMOL Platforms could provide a basis for creating a new kind of place that, like real or augmented worlds as described above, provides context for human action and intention. A key feature of a 3D virtual learning environment as opposed to text-based MUD's (Multi User Dungeon) or LCMSs is the ability for teacher/students to visualize the presence and location of other participants. They are developed to provide learners with an environment in which to construct their knowledge and develop a learning community through a 'real' social interaction. Learners conducted contextual discussions and collaborated with their peers and tutors at the learning space and levels of learning in the virtual or mixed place. The theory underlying these assumptions and the translation from theory into a specification for a virtual place has been explored by Kalay (Kalay, 2004)

One of the significant commonalties of our research method is building rich education places on MMOL platforms in order to create specialized simulations and role-plays on diverse curricular topics. The relationship between learners, their learning activities, and the environment in which it takes place is reciprocal: learners create an activity within a specific environment. Thus, we created three educational places - from the multi-case method perspective- and carried out their respective activities and collaborative tasks. The first place is called *MadriPolis* and we used it to practice students' skill to enhance the depth of student ability in collaborative evaluation tasks. The same place was later used for the second case, but with a slightly different focus. This place is now the backbone of teachers' skills improvement in areas like diversity, equity and inclusion in education. The third place is called SLRoute and we used it for foreign language learning. Moreover, SLRoute offers a means of gaining a deeper understanding of other cultures, in particular The Way of St. James (*Camino de Santiago*) culture, which can serve as a basis for building better understanding between persons and communities. In this way, an informal learning network exists and the learning can be more broadly shared. This place and in-world-based activities involve more than just learning foreign languages.

Here we find another area on which our research is based, such as collaborative and cooperative learning. As we explained in previous chapter, collaborative and cooperative tasks are especially beneficial to learners' skills improvement, in particular for students with learning differences. These tasks were conducted in places described above with a clear educational goal and promoting a safe and secure learning environment. Most collaborative activities were designed with the collaborative learning tenets, such us:

- Promote group process by assigning roles. Learners coached on group process skills-supporting differences, listening, providing feedback, gatekeeping to ensure all participate, coaching others, reaching consensus.

- Each student is accountable for a specific task or topic as well as topics assigned to other group members.
- Leaders keep groups on task, ensure everyone participates and understands.
- Recorders manage group files and folders, tracking each team member's contributions.
- Each team and member benefits when all members perform well, and is held accountable when one or more members do not; "sink or swim together".

Therefore, our research method approach is based on three essential pillars, a suitable selection of virtual places and environments, leveraging innovation in response to growing learner's demands and collaborative learning principles.

1.9 Research Contributions.

This thesis is aimed at fulfilling the aim of providing that the MMOL setting was hypothesized to achieve a better collaborative experience. The assessment employed Social Network Analysis (SNA) techniques, proved statistical tools and test, like Standards Performance Continuum (SPC) (Doherty, Hilberg, Epaloose, and Tharp, 2002; Hilberg, Doherty, Epaloose, and Tharp, 2004), and Technology Acceptance Model (TAM) (Davis, 1989) to measure the impact of our proposals with sufficient accuracy, and to analyse outputs and outcomes along with qualitative and quantitative information gathered from experiences and research findings. The main contributions are the following:

- Definition of MMOL (Massively Multiuser On-line Learning) platform as mixed reality environments constructed over virtual world servers that provide an interactive learning space by means of 2D, 2.5D or 3D technologies to build and manage collaborative and ongoing online learning environments in which individuals participate using a real or a figurative presence, i.e., avatar) (Lorenzo, 2010; Lorenzo, Sicilia and Alonso, 2012).
- Overall characterization of MMOL platform' components and resources in order to develop rich immersive experiences.
- Guides and recommendations about how to develop collaborative evaluation task in MMOL platforms.
- Specific instances of use of 4D Framework (de Freitas & Oliver, 2006; de Freitas et al., 2010) for collaborative purposes on MMOL platforms.
- Adaptation of Convergent Participation Model (CPM) for Learning Object evaluation using the Learning Object Review Instrument (LORI) in-world.
- Guides and recommendations about how to implement in-world simulations and role-play activities about diversity issues. Adaptation of Ford and Harris framework (Ford and Harris,

1999) to devise innovating and fun in-world activities, and learning and training strategies.

- Guides about to bring about transformation of classroom from whole-class, teacher-centered instruction to activity center instruction (Hilberg, Chang, and Epaloose 2003), based on the principles of Effective Pedagogy (Tharp, Estrada, Dalton, and Yamauchi, 2000) and in-world collaborative and cooperative tasks.
- Blueprints about how to create an instructional unit using activity centers as immersive scenarios on MMOL platforms.
- Good practice and examples for increasing user's acceptance of 3D learning environments.
- Adaptation of Technology Acceptance Model (TAM) (Davis, 1989) to establish the user's perception model of MMOL platforms.

Chapter 2. *MMOL Platforms.*

2.1 A general approach to the MMOL Platform concept.

Different kinds of virtual environments are being increasingly used by universities and other institutions to enhance the learning experience of their students and staff (Menon, 2010). Collaborative Virtual Environments (CVEs) are nowadays a widespread collaboration and interaction platform for geographically dispersed participants. A CVE has been defined as follows:

> *"A computer-based, distributed, virtual space or set of places. In such places, people can meet and interact with others, with agents or with virtual objects. CVEs might vary in their representational richness from 3D graphical spaces, 2.5D and 2D environments, to text-based environments. Access to CVEs is by no means limited to desktop devices, but might well include mobile or wearable devices, public kiosks, etc."* (Snowdon, Churchill, & Munro, 2001).

Representational richness can also be extended to cover inputs such as sound and touch interfaces (Bailenson, Yee, Blascovich, Beall, Lundblad& Jin, 2008). Browman proposes the term "Immersive Virtual

Reality" (IVR), which can be defined as "complex technologies that replaced real-world sensory information with synthetic stimuli such as 3D visual imagery, specialized sound, and force or tactile feedback" (Bowman & McMahan, 2007). Among existing IVR, a category of virtual reality applications is designed for single user access which can be used in learning settings such as simulation or virtual experiences, as well as exploration of structures, spaces, buildings and other elements (Jackson & Fagan, 2000; Patel, Bailenson, Hack-Jung, Diankov & Bajcsy, 2006). However, another category of systems is oriented to interaction inside groups of users, leading to immersive multi-user virtual environments that not only enable a perception of virtual presence resembling the real world but also supports collaborative activities through a number of tools. Virtual worlds can be viewed as a concept closely related to this one (Livingstone, Kemp & Edgar, 2008; Hendaoui, Limayem & Thompson, 2008). Unlike immersive multi-user virtual environments, virtual worlds are not only characterized by immersion and a feeling of presence and social interaction, but also by a long-lasting online environment where a large population of users can interact over time, with no time constraints. Recent examples of these environments or Virtual 3D Worlds (V3DW) are built on 3D models and enhanced 3D graphic and audio world presentations, but the human interaction "inside the world" is mainly restricted to a 2D computer screen, stereo sound, keyboard and mouse. This interface and user context is known as 2.5D. Such settings are viewed as not entirely immersive but are closer to technology that is mainstream in the consumer market (such as 3D displays, 3D video consoles or 3D Blu-Rays), and it is likely that such technology, together with improved interfaces, will soon overcome those restrictions (Kappe & Gütl, 2009; Schroeder, 2008, Sivan, 2008)

2.2 MMOL Platform definition.

In view of the above, this is the perspective from which we consider Massively Multiuser On-line Learning (MMOL) platforms: immersive contexts including both a multi-user environment and a rich interface to combine real and virtual reality. However, it is important to bear in mind that we shall study MMOL platforms from an educational perspective which should always have a clear educational purpose. Therefore, this term may be defined as follows:

> *"Mixed reality environments constructed over virtual world servers that provide an interactive learning space by means of 2D, 2.5D or 3D technologies to build and manage collaborative and on-going online learning environments in which individuals participate using a real or a figurative presence (avatar)"* (Lorenzo, 2010).

2.3 Differences between MMOL platforms and virtual worlds

The main differences between MMOL platforms and V3DW or immersive multi-user virtual environments are the following:

- A clear educational purpose.

- The integration of learning technologies/functions according to a convergent view.
- The integration of the "real life learning experience" "augmented learning experiences" and "virtual learning experiences" in the same virtual environment (mixed reality environments).
- The absence of a "darker side" (Berge, 2008b) or questionable context from the standpoint of individuals engaged in the educational process.
- The easy integration and reuse of 3D Objects, MOLs or RMOLs to implement rich educational contexts.

2.4 MMOL platforms architecture.

A generic conceptual architecture of MMOL platforms is depicted in Figure 3 which conceptualizes an MMOL platform from the perspectives of virtual/real participation on the one hand, and pedagogy on the other. As far as user participation is concerned, the access mode could be full immersive, 3D or 2.5D. The pedagogical framework, as explained below, is based on the use of collaborative and management tools like virtual world servers, collaboration and user profiling tools, storyboard kits and guides. The MMOL platform must be integrated with external services like WebDav, conventional LCMSs, repositories or 3D content creation suites.

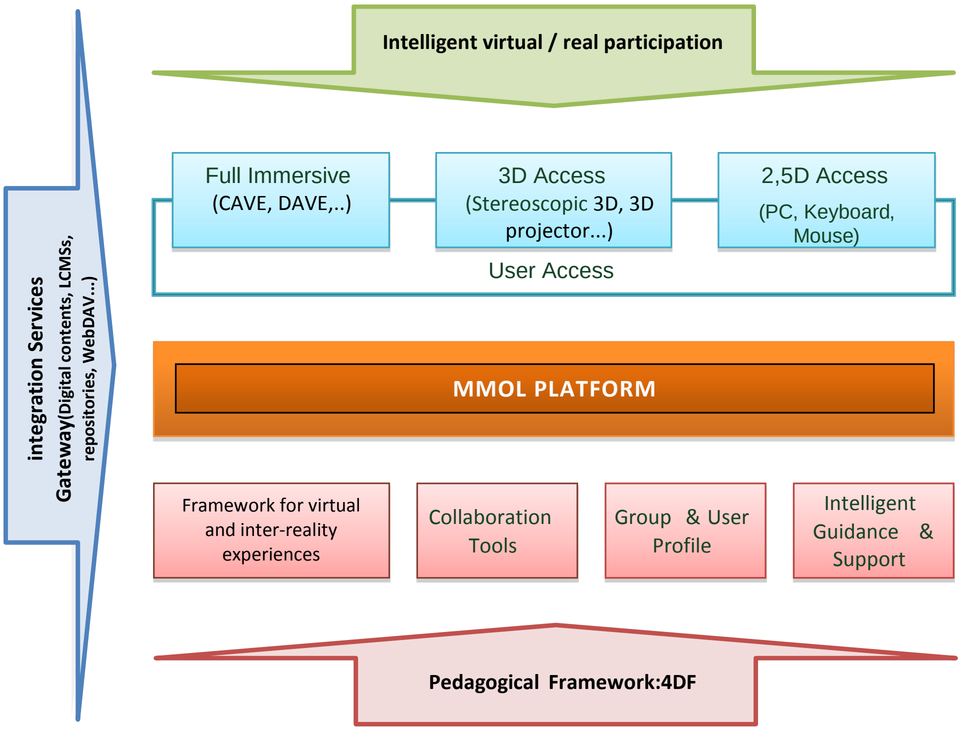


Figure 1 . A generic MMOL platform Architecture.

Open virtual world servers and optimal render engines are the bedrock of MMOL platforms and, more particularly, the framework for virtual and inter-reality experiences. The server's functionalities need to be adapted in order to construct new convergent learning context. Anyway, one of the critical aspects of expanding the use of virtual worlds is their interoperability capabilities and subsequent, the possibilities they allow for analyzing data represented using common schemas (Lorenzo, 2011; Lorenzo et al., 2012)). Prominent examples of these virtual servers are:

- ***OpenSim*** (http://opensimulator.org/). The OpenSimulator project is a virtual world server for creating 3D virtual environments. It has been described as a reverse engineered Second Life that allows users to run their own Second Life Island on their own computer, and it is even possible to move objects between OpenSim and Second Life. OpenSim can be run as a standalone application or as a virtual world network in grid mode. Written in C# over .NET framework or MONO Project, it is modular, allowing developers to augment it with new functionalities via plug-in modules (similar to Apache web server). It is a real alternative to Second Life (SL) without a "darker side" (Berge, 2008b).
- ***Croquet*** (http://www.opencroquet.org). Croquet is an open source software development environment for creating and deploying deeply collaborative multi-user online applications on multiple operating systems and devices. Developed from Squeak, it features a peer-based network architecture that supports communication, collaboration, resource sharing, and synchronous computation between multiple users on multiple devices. Using Croquet, software developers can create and link powerful and highly collaborative cross-platform multi-user 2D and 3D applications and simulations – thus enabling the distributed deployment of very large scale, richly featured and interlinked virtual environments.

- ***Open Wonderland*** (http://openwonderland.org/). Project Wonderland, based on Sun Microsystem's Darkstar render technology, is a Java virtual world toolkit for creating collaborative experiences. The main strengths of the project, as with many social worlds, have to do with collaboration and information representation through the use of stereo audio, shared applications and video streaming. The project is open source, so developers and graphic artists can extend it with new functionalities in order to create entire new worlds, new features in existing worlds, or new behaviors for objects and avatars.
- ***realXtend*** (http://www.realxtend.org). realXtend is a free open project that extends the feature set of OpenSim in order to support normal 3D meshes, Python and JavaScript languages which have not been available in OpenSim. realXtend could be used as the basis for creating impressive, entertaining, educational and functionally diverse virtual environments and multiplayer 3D games. When we implemented the thesis's experiences realXtend technology includes a robust server (Taiga) and a new browser totally independent of the Second Life viewer (Naali). Furthermore, the server allows integration with useful services, like OpenID authentication, WebDAV inventory, HTTP assets and so on, and supports the Ogre3D rendering engine. The viewer provides anaglyphic stereoscopic and CAVE

rendering. However, the realXtend technology is in constant evolution and update according to the most recent developments. So, the actual version is evolved to a new server technology known as "Tundra". Codebase is shared by both the server and the viewer. The API is also shared by the server and the viewer, making it possible to utilize the same JavaScript or Python code in both. All of these features are intended to make creation and deployment of diverse applications simpler and more cost-effective.

The Second Life architecture and thus to an extent OpenSim, have a fairly specific scene model based on separate primitive objects, avatars, terrain etc. realXtend has a flexible entity-component based architecture, whose purest implementation exists in the Naali / Tundra combination, which is directed more towards being a generic 3D application platform instead of a specific kind of a virtual world. For creating large multiuser virtual environments OpenSim offers many advantages, like for example safe sandboxed LSL scripting for user-to-user content. For this reason our experiences make use both OpenSim and realXtend technologies.

However, technology is not enough to build a virtual learning world. The appropriate educational context includes the following: a framework for virtual and inter-reality experiences, collaboration tools, group and user profile and support. Therefore, MMOL platforms need to include:

- 3D development tools for building realistic scenarios and simulations.
- Script languages to manipulate the behavior and aspect of the in-world object and bots.
- A rendering engine for educational games.
- Toolboxes to describe sessions' storyboard and '*gamification*'.
- Utilities for NPCs (Non Player Characters) or chatbots creation.
- Languages to provide bots Artificial Intelligent, like AIML (Artificial Intelligence Mark-up Language).
- Services to integrate mirror worlds.
- Management tools to manage courses, students, teachers, etc.
- Toolkits to build software augmented reality systems.
- Synchronous communication tools such as live chat, videoconferencing.
- Co-browsing displays.
- Logical interfaces with haptic devices.
- Speech to Text (STT) and Text to Speech (TTS) tools.
- Scripting languages to analyze relationships and data mining.
- Web Services like LDAP, WebDAV and LCMS integration.

2.5 What does MMOL Platforms bring to teachers and learners?

MMOL platforms provide educators and students with the ability to connect and integrate all technologies and pedagogical principles in a way may potentially enhance the learning experience. Thus, the teacher could make use of a rich context to interact and collaborate with the students in a synchronous mode. The synchronous capabilities of MMOL platforms allow for a redefinition of the traditional teacher's role.

On the whole current e-learning approaches are based on the use of LCMSs and mainly rely on communication in asynchronous mode, using tools like forums, e-mail, HTML documents, blogs or webQuests. The collaborative aspects of virtual learning environments engage students in on-line dialogue and discussion that is open-minded and cooperative in contrast to off-line debate, which is often narrow-minded and competitive. When used as learning platforms, virtual learning environments enforce student participation in a real immersive context, enabling learners to take a more active role in their learning. Moreover, MMOL platforms afford the means to take advantage of the pedagogical opportunities offered by V3DW or immersive multi-user virtual environments. In order to leverage the combination of communication tools, sense of immersion and opportunities for collaboration described above, social constructivist theories would seem to be the most appropriate (Girvan & Savage, 2010). However, 3D settings are assumed to bring about new possibilities but also new challenges when used as learning environments for online education (Petrakou, 2010). Their most significant contribution is the possibility of building active and realistic knowledge networks between real and figurative persons (avatars) around the world in a multi-user and mixed reality learning context which brings MMOL platforms to a realization of an environment supporting connectivism theory (Siemens, 2008). Additionally, they can provide exploratory learning, role-play simulations and diverse types of scaffolding to accommodate individual cognitive differences, cases in point being Situated Learning (Lave & Wenger, 1991) and Problem-Based Learning based on the educational theories of Vygotsky (Barrell, 1999). Therefore, the pedagogical framework of this new virtual context is based on the broad principles through which these theories are applied specifically to teaching practice. One benchmark is the Four Dimensional Framework - 4DF (de Freitas & Oliver, 2006; de Freitas et al., 2010) that provides a conceptual structure for understanding immersive learning, and has implications upon learning design as a whole.

This thesis reports the outcome of a study of MMOL platforms for the specific task of collaborative and cooperative learning. That kind of collaborative tasks is common in social learning theories in general, and can be applied to a wide range of situations. As indicated in the chapters below, MMOL Platforms were hypothesized to achieve a better collaborative experience.

Chapter 3. *A multiple-case study approach.*

3.1 General description of multi-case method.

Case studies provide an opportunity for in-depth exploration of a specific learning activity in action (Stake, 1995). Case study is referred to as a method, a strategy and an approach (Simons 2009).

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context especially when the boundaries between phenomenon and context cannot be drawn clearly or unambiguously. In fact, this is the main characteristic that we can find when we try research educational phenomenon through the use of Information Society tools. In our case, context is more often defined by virtual places specially designed for collaborative tasks on MMOL platforms. There are different types of case studies, which are described using various terminologies. It is important to determine at the outset what type of case study to use (Stake, 1995; Stake, 2006; Bassey, 2008; Baxter, 2008; Simons, 2009; Yin, 2009). We draw primarily on Stake and Bassey, who write about case studies in educational settings. Stake (1995; 2006) divides case studies into three types: the intrinsic case study, the instrumental case study and the collective case study/multiple-case study. The intrinsic case study is a study of one particular case that the researcher wants to understand better. The interest is not in general issues. This is what Bassey (2008) defines as a story-telling and picture-drawing case study. In the instrumental case study, focus it is not on the specific case, but the issue. The purpose is to gain insight into a larger issue or phenomenon or to test, refine or build a theory. This can be compared to theory seeking and theory testing case studies (Bassey 2008). The collective/multiple-case study is an instrumental case study with a number of cases. The multi-case study enables the exploration of differences between cases and the comparison of findings across cases. In the present thesis we are interested in producing knowledge that goes beyond the single case. Furthermore, we have theoretical assumptions that participation, concerns, co-participants, contexts and structures of practices have significant influence on couplings between learners' skills improvement and the use of MMOL platforms. That makes it relevant and interesting to be able to explore variables in cases and compare the findings across different cases. This should make it possible to produce knowledge about the significance of use MMOL platforms in students' everyday life. Adopting a multiple-case study approach may provide an adequate research strategy for addressing the potential impact of MMOL platform on training learner's skills.

3.2 Methodology

Many well-known case study researchers such as Stake, Simons, or Yin have written about multi-case study methodology and suggested techniques for organizing and conducting the research successfully. This chapter describes the design and methodology of this study that examined the influence of MMOL platforms in learners' skill improvement. A quantitative and qualitative, multi-case study approach was used to inform the research questions. A statement of the problem and purpose of the study provides background information concerning the research questions. The population and sample are identified and the procedure for conducting the study is detailed. The use of a pilot study to validate collect data in the field is implemented in advance; and specific procedures, data collection, and data analysis issues are addressed. Six steps that should be used:

1. Determine and define the research questions.
2. Select the cases and determine data gathering and analysis techniques.
3. Prepare to collect the data.
4. Collect data in the field.
5. Evaluate and analyze the data.
6. Prepare the report.

3.2.1 Determine and define the research questions.

In conducting a case study it is important to be very specific in the definition of the whole, the cases and the unit of analysis (Stake 1995; Stake 2006; Bassey 2008; Baxter 2008; Simons 2009; Yin 2009). In a multi-case study the cases are interesting because they belong to a particular collection of cases with something in common and thereby reveal something about the whole. Stake (2006) calls the whole the '*quintain*', which is a conceptualization or phenomenon that binds all single cases together. The dilemma then is not to lose sight of the '*quintain*' by focusing too much on any one single case study and vice versa. A '*quintain*' is often better understood by looking at the way things are handled than by looking at efficiency or outcomes.

The '*quintain*' we want to produce knowledge about is '*how collaborative and cooperative learning improve when we use educational virtual worlds or MMOL platforms*'.

3.2.2 Select the cases and determine data gathering and analysis techniques

During the design phase of case study research, we determine what approaches to use in selecting single or multiple real-life cases to examine in depth and which instruments and data gathering approaches to use. When using multiple cases, each case is treated as a single case. Each case's conclusions can then be used as information contributing to the whole study, but each case remains a single case. Exemplary case studies carefully select cases and carefully examine the choices available from among many research tools available in order to increase the validity of the study. In this sense, we determine whether to study cases which are unique in some way or cases which are considered typical and may also select cases to represent a variety of geographic regions, a variety of size parameters, or other parameters. A useful step in the selection process is to repeatedly refer back to the purpose of the study in order to focus attention on where to look for cases and evidence that will satisfy the purpose of the study and answer the research questions posed. Selecting multiple or single cases is a key element, but a case study can include more than one unit of embedded analysis. For example, a case study may involve study of others in a recursive approach, such as our collaborative evaluation case. This type of case study involves several levels of analysis and increases the complexity and amount of data to be gathered and analyzed.

As we explain below we selected three exemplary case studies:

- Group's role-play to improve group's skill. The case of collaborative evaluation of Learning Objects.
- Teacher's role-play to improve teacher's skill. The case of teacher skills improvement in diversity, equity and inclusion.
- Learner's role-play to improve learner's skill. The case of student skill improvement in foreign languages learning and technology acceptance.

Case studies are preceded by a pilot study to validate all research components and developments. This pilot is a group role-play activity to develop interpersonal skills; e.g. capacity of balanced judgment, ability to work in teams, ability to cope with difficult situations, respect for local attitudes, good communication skills, and readiness to work in a multicultural environment. One of the most relevant pilots focused on the so-called 'moral dilemma'. The aim was to exercise peaceful co-existence between the Islamic and Christian populations, in particular the use of headscarves in schools.

A key strength of the case study method involves using multiple sources and techniques in the data gathering process. So, we determine in advance what evidence to gather and what analysis techniques to use with the data to answer the research questions. In most cases, data gathered is largely qualitative, but it may also be quantitative. In our cases, tools to collect data include surveys, direct observations, documentation review, log files, and even the collection of virtual places.

3.2.3 Prepare to Collect the Data

Because researched case study generates a large amount of data from multiple sources, systematic organization of the data is important to prevent data loss and sight of the original research purpose and questions. Advance preparation assists in handling large amounts of data in a documented and systematic fashion. To achieve this, we prepare databases and Excel spread sheets to assist with categorizing, sorting, storing, and retrieving data for analysis. To finish this step, we anticipate key problems and events, identify key people, prepare projects documentation, establish rules for confidentiality, and actively seek opportunities to revisit and revise the research design in order to address and add to the original set of research questions.

3.2.4 Collect data in the field

After finishing the previous step, we collect and store multiple sources of evidence comprehensively and systematically, in formats that can be referenced and sorted so that converging lines of inquiry and patterns can be uncovered. We carefully observe the object of the case study and identify causal factors associated with the studied phenomenon: relationships between participants, behavioral patterns, conflict and development strategies, etc. Renegotiation of arrangements with the objects of the study, like learning objects, storyboard templates ... or addition of questions to interviews may be necessary as the study progresses. Case study research is flexible, but when changes are made, they are documented systematically.

One of the mandatory requirements of our research is maintaining the relationship between the issue and the evidence. We enter some data into a database and spread sheet, and physically store other data, but the researcher documents, classifies, and cross-references all evidence so that it can be efficiently recalled for sorting and examination over the course of the study. UCINET matrixes, TAM questionnaires, Standards Performance Continuum (SPC), specific interviews were the base of data collection in the field.

3.2.5 Evaluate and analyze the data.

When data collection finishes, we examined raw data using many interpretations in order to find linkages between the research object and the outcomes with reference to the original research questions. Throughout the evaluation and analysis process, the researcher remains open to new opportunities and insights. The case study method, with its use of multiple data collection methods and analysis techniques, provides us with opportunities to triangulate data in order to strengthen the research findings and conclusions.

Specific techniques include placing information into arrays, creating matrices of categories, creating flow charts like SNA visualizations, and tabulating frequency of events. We use the quantitative data that has been collected to corroborate and support the qualitative data which is most useful for understanding the rationale or theory underlying relationships. Another technique, the cross-case search for patterns, keeps us from reaching premature conclusions by requiring that we look at the data in many different ways. Cross-case analysis divides the data by type across all cases investigated. Then, the data of that type were thoroughly examined. When a pattern from one data type is corroborated by the evidence from another, the finding is stronger. When evidence conflicts, deeper proving of the differences is necessary to identify the cause or source of conflict. In all cases, we treat the evidence fairly to produce analytic conclusions answering the original 'how' and 'why' research questions.

3.2.6 Prepare the report.

Exemplary case studies report the data in a way that transforms a complex issue into one that can be understood, allowing the reader to question and examine the study and reach an understanding independent of the researcher. Case studies present data in very publicly accessible ways and may lead the reader to apply the experience in his or her own real-life situation. We pay particular attention to displaying sufficient evidence to gain the reader's confidence that all avenues have been explored, clearly communicating the boundaries of the case, and giving special attention to conflicting propositions.

Techniques for composing the report can include handling each case as a separate chapter, as in our case. Other techniques are treating the case as a chronological recounting or reporting the case study as a story. During the report preparation process, we critically examine the document looking for ways the report is incomplete. We use specialists to review and comment on the draft document. Based on the comments, we rewrite and make revisions. The document review audience includes journal reviewers and some participants in the study.

Case studies are complex because they generally involve multiple sources of data, may include multiple cases within a study, and produce large amounts of data for analysis. Researchers from many disciplines use the case study method to build upon theory, to produce new theory, to dispute or challenge theory, to explain a situation, to provide a basis to apply solutions to situations, to explore, or to describe an object or phenomenon. The advantages of the case study method are its applicability to real-life, contemporary, human situations and its public accessibility through written reports. Case study results relate directly to the common reader's everyday experience and facilitate an understanding of complex real-life situations, such as learning and training activities

3.3 Selected case studies overview.

Our research is based in three exemplary case studies preceded by a pilot study, above described, that allows us to ensure that developments and the basis for multi-case study research are valid.

5.3.1 Group's role-play to improve group's skill. The case of collaborative evaluation of Learning Objects.

MMOL platforms constitute a still unexplored context for communication-enhanced learning, where synchronous communication skills in an explicit social setting enhance the potential of effective collaboration. In this case study, we report on an experimental study of collaborative evaluation in an MMOL setting with 21 graduate students enrolled in university courses in technology-mediated teaching and learning. This study was carried out using a prototype of a 3D MMOL platform built around an interactive space called "*MadriPolis*". This space was used to recreate an adequate scenario for a collaborative experience about Learning Object evaluation using the mainstream Learning Object Review Instrument (LORI), which is based on a Convergent Participation Model (CPM). The same experience was carried out using a conventional LCMS (Learning Content Management System) platform with the aim of contrasting the outcomes and interaction patterns in the two settings. This study makes use of Social Network Analysis (SNA) measures to describe the interactions between tutors and learners. By dwelling on the advantages of immersive environments, SNA indexes revealed that these interactions were rather dense and that student participation was rather broad-based in the case of the MMOL.

3.3.2 Teacher's role-play and simulation to improve teacher's skill. The case of teacher skills improvement in diversity, equity and inclusion.

Today's education is characterized by the need to adapt teaching – learning processes to the new social, demographic and cultural reality due to world events and societal changes emerged in past decades. These changes must be analyzed in detail in order to identify the most effective education strategies and options and to see how best to include initiatives for support teacher training in the prevention and settlement of conflicts. These teachers' skill may be reinforced by MMOL platforms adoption to favor the creation of 3D places, such as *MadriPolis*, and role-play activities where the teachers can improve their teaching-pedagogical skills for situations of cultural and ethical concerns that require a high level contextualization. This study focuses on main areas as diversity, equity and inclusion in education. Teachers and students of secondary education enrolled at Spanish Secondary Schools were the population under study. The ultimate aim is to demonstrate whether MMOL platforms can improve teachers' skills training through the use of virtual and/or augmented reality simulations.

3.3.3 Learner's role-play to improve learner's skill. The case of student skill improvement in foreign languages learning.

This study is a specific initiative combining proven teaching methods in university classroom experiences with the creation of new multidisciplinary content displayed on MMOL platforms. The objective of this research, supported by the SLRoute project, is the creation of integrated technology platform that enables the creation, development and deployment of contents for teaching Spanish in a rich educational 3D environment. Such environment will promote an immersive, creative and collaborative experience in the process of learning Spanish. The project aims at developing an educational game in an immersive platform as a tool for foreigners to learn Spanish. SLRoute is conceived as an integration of Spanish language teaching with aspects of Spanish culture and history. In particular, a collaborative history can be followed during the game, contextualized in the form of scenarios within the different stages of the Way of St. James (*Camino de Santiago*). The main goal of this case is to measure and increase user's satisfaction when an immersive experience takes place.

Chapter 4. Case One. Collaborative evaluation of Learning Objects.

4.1 Introduction

This case study reports the outcome of a study of MMOL platforms for the specific task of collaborative evaluation, considering the simulated-based learning approach. That kind of evaluative task is common in social learning theories in general, and can be applied to a wide range of situations. In our study, we focus on the evaluation of learning objects by means of mainstream evaluation instruments and methods. The approach to the evaluation is based on contrasting the evaluation task in two settings: the MMOL setting and a conventional setting using an LCMS and asynchronous interaction. Provided that the MMOL setting was hypothesized to achieve a better collaborative experience, the assessment employed Social Network Analysis (SNA) techniques to analyze the interaction patterns. As we explain below, this case study is a composition of other two case studies, which is considered as a '*meta-case study*'.

The rest of this study is organized as follows. Next section presents the objectives and setting for the experiences conducted. Section 3 sets out the two case studies of learning experiences used to obtain significant data collections. Section 4 presents and evaluates the data and results from the case studies. Finally, in Section 5 some conclusions are drawn.

4.2 Resources and settings

The main focus of our study is the analysis of collaborative contexts in a technology-enhanced immersive learning context, like that provided by MMOL platforms, analyzing the key roles involved in collaborative educational tasks. More particularly, we analyze tutor and learner interaction patterns with the aid of a comparative case study. The aim of this paper is therefore to explore how a specific MMOL platform can facilitate tutor and learner collaborations in a rich virtual learning environment. The educational framework of Sara de Freitas (Freitas & Oliver, 2006) is our point of departure. The empirical findings are obtained from a case study carried out separately in two platforms, MMOL and LCMS, which in both cases were prepared to recreate an adequate scenario for simulated collaborative evaluations of Learning Objects. The results of these experiences were analyzed using Social Network Analysis (SNA) techniques with a view to evaluating the improvement in the density and centralization indexes in terms of socio-centric networks when using MMOL platform as against conventional 2D LCMSs like BlackBoard, WebCT or Moodle. To examine these hypotheses, a learning experience about Leaning Object (LO) evaluation based on LORI (Learning Object Review Instrument) and CPM (Convergent Participation Model) (Vargo, Nesbit, Belfer & Archambault,

2003) was set up by deploying realXtend configured specifically for the task with a specific place called *MadriPolis*.

4.2.1 Overall description of the settings

The study presented here contrasts an MMOL with a conventional LMS in relation to the task of collaborative evaluation. The rest of this section describes the configuration and design of the two virtual spaces contrasted. In both cases, the purpose of the activity is the same: to perform a collaborative evaluation.

'The process consists of two key components: the Learning Object Review Instrument (LORI) that an individual evaluator can use to rate and comment on the quality of a learning object, and the Convergent Participation Model that brings together a team of evaluators and their individual reviews to create and publish a collaborative LORI review' (Vargo et al., 2003). In its capacity of a learning objects evaluation tool, LORI allows reviewers to rate and comment on nine items (version 1.5): content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability and standards compliance. 'Convergent Participation is a two-cycle model designed to boost the efficiency and effectiveness of collaborative evaluation. In the first cycle, participants with diverse and complementary areas of expertise individually review a set of learning objects using LORI. The first cycle is completed asynchronously within a period of few days. In the second cycle, the participants come together in a moderated discussion using a synchronous conferencing system. During the discussion, participants adjust their individual evaluation in response to the arguments presented by others. At the end of the meeting, the moderator seeks consent of the participants to publish a team review synthesized from the mean ratings and aggregated comments' (Vargo et al., 2003). We adapted the second cycle to our case studies.

4.3 MMOL setting

4.3.1 The educational framework

In order to create an adequate collaborative evaluation scenario in the MMOL platform we considered the 4DF (de Freitas & Oliver, 2006; de Freitas et al., 2010). The basic scaffold holds good in the four dimensions:

- The first dimension defines the context where learning is undertaken. This context includes the wider historical context as well as the specific learning context.
- The second dimension involves the learner specification or group learner specification: learner profile, pathways or learning background.
- The third dimension focuses upon the internal representational world, how interactive the learning experience needs to be, what levels of fidelity are required, and how immersive the experience needs to be.
- The fourth dimension analyses the pedagogic aspects of the learning activities, and includes a consideration of the kinds of learning and teaching models adopted alongside

the methods for supporting the learning processes (Freitas & Oliver, 2006; Freitas & Neumann, 2009; Freitas et al., 2010).

The next table summarizes the 4DF in our MMOL experience (Table 1).

1D: Context	2D: Learner	3D: Representation	4D: Pedagogic Considerations
On-line postgraduate courses/research about technology mediated learning and teaching.	Graduate students	MMOL experience uses a medium level of fidelity based upon the use of 2D, 2.5D and 3D animated avatars, bots and contents (see setting list below).	Learning outcomes from this experience would support increased empathy with others and tutor's roll.
Virtual learning world - based	The tool is used with groups of Masters students and researchers.	MMOL experience uses a high level of interactivity between the media world and the learners' own experiences and knowledge, allowing the student to develop increasing synchronous collaboration capabilities with well-known rules and functionality (see setting list below).	Learning activities for this experience focused upon playing as LORI reviewer and/or tutor coordinator. The student learns through activities based in synchronous role-playing
The experience supports the In-world Convergent	The experience can only be carried out collaboratively as part	MMOL experience includes a high level of realism in terms of the	Briefing / debriefing should have been embedded into how the

Participation Model (Vargo et al., 2003)	of the pilot experiences. However the students can read and use several contents individually.	classroom exercise where the participants behave as tutors and/or reviewers	experience was performed and would have helped reinforce learning outcomes and add greater engagement to the process.
Interactions with virtual world and other participants	The tool would potentially support a range of differentiated learners with different learning styles		Simulation embedded as a practical session of the on-line tutor tasks and reviewer's roll.

Table 1. Using the 4DF to implement MMOL experience.

4.3.2 The educational scenario

The MMOL experience uses different pieces of software and dedicated hardware, and therefore needs a high level of technical support. The following setting list includes objects and services for adequate implementation of the internal representational world dimension of the MMOL experience:

- 2.5 D access via realXtend viewer 0.42 release and Naali viewer 0.3.1 release.
- 3D access via stereo vision driver and 3D glasses with Naali viewer.
- Framework for virtual and inter-reality experiences constructed with a realXtend / Taiga server 0.2 rc1. The LORI evaluation was conducted within a virtual space named '*MadriPolis*'. Figures 2 to 5 show the building structure and the collaborative space of '*MadriPolis*'.

Figure 2. MadriPolis in realXtend

Figure 3. MadriPolis evaluation meeting point

Figure 4. MadriPolis collaborative space I

Figure 5. MadriPolis collaborative space II

- Collaboration Tools. In our experience we used the following collaboration tools: chat, voice chat and videoconferencing systems, whiteboard, shared desktop, shared presentation, Google documents and co-browsing tools. The co-browsing viewer (see Fig. 6), for instance, allowed joint navigation through the most relevant pages and contents of the LO under evaluation, while the voice chat allowed students to exchange ideas and opinions synchronously (Fig. 7).

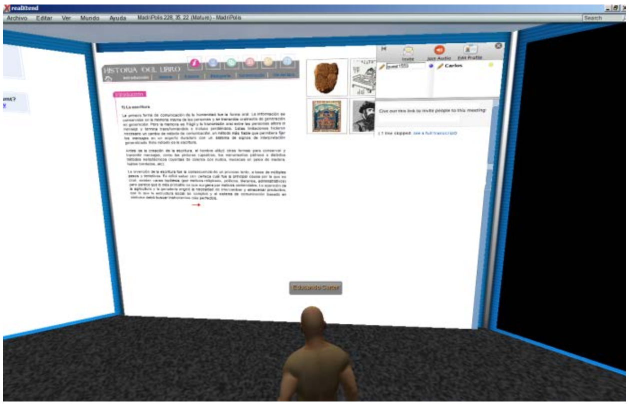


Figure 6. Co-browsing viewer

Figure 7. Shared Presentation.

- Group and user profile. As a derivative of realXtend server, the MMOL platform provided us with two important functionalities: authentication server (keeps records of users and handles authentication) and avatar storage server that stores and delivers avatar data.

- Intelligent guidance. Students could use in-world panels and bots to complete their learning itinerary and read in-world the LORI manual and the Convergent Participation Model document.
- 2D Services Integration Gateway:
    (a) Google document spread-sheet to calculate the average values of LORI items (See Figure 8).
    (b) Desktop shared tools to show application procedures.
    (c) Co-browsing viewers to surf learning contents as a collaborative experience.
    (d) YouTube in-world video browser.
    (e) In-world interactive whiteboard.

Figure 8. In-world Google document to determine average values of LORI items

4.4 LCMS setting.

4.4.1 The educational framework

The LCMS server selected was Moodle. This experience was also conducted with 4DF (Table 2).

1D: Context	2D: Learner	3D: Representation	4D: Pedagogic Considerations
On-line postgraduate courses/research about technology-mediated learning and teaching.	Graduate students	MMOL experience uses a low level of fidelity based upon the use of 2D interface and contents (see setting list below).	Learning outcomes from this experience would support increased empathy with others and tutor's role
LCMS (Moodle) - based	The LCMS is used with groups of Masters students and researchers.	LCMS experience uses a medium level of interactivity between the on-line course and the learners' own experiences and knowledge. The participants could only hold off-line debates (see setting list below).	Learning activities for this experience focused upon playing as LORI reviewer and/or tutor coordinator. The student learns through activities based on asynchronous role-playing
The experience supports an adaptation of Convergent Participation Model (Vargo et al., 2003) adapted to LCMS	The experience can only be carried out as a group activity, but the discussions are always off-line.	LCMS experience includes a medium level of realism in terms of the classroom exercise where the participants behave as tutors and/or reviewers	Briefing / debriefing should have been embedded into how the experience was performed and would have helped reinforce learning outcomes and

communication tools.			add engagement to the process.
Asynchronous interactions with LCMS and other participants	The tool potentially would support a range of differentiated learners with different learning styles		Simulation embedded as a practical session of the on-line tutor tasks and reviewer's role.

Table 2. Using the 4DF to implement LCMS experience

4.4.2 The educational scenario

The next setting list includes the objects and services for an implementation of the educational scenario in the LCMS of the experience:

- Learning Objects collaborative evaluation course.
- LORI manual and CPM document.
- Link to the URL of the Learning Object under evaluation / to be evaluated.
- Individual participation discussion boards.
- Collaborative participation discussion boards.

The following figure shows the 2D course structure and elements.

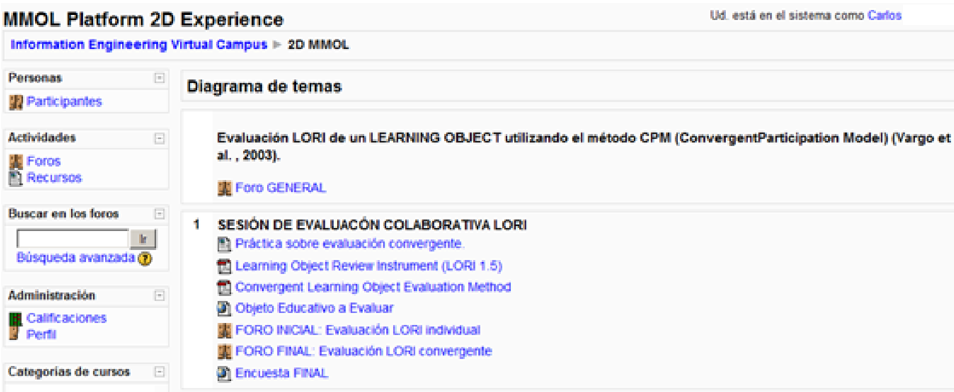


Figure 9. Course over LCMS

The LCMS platform has standard tools to facilitate asynchronous capabilities like blogs, discussion boards (forum), internal e-mail or wikis. In this context, the most useful on-line tutor functionality for providing an interactive venue where teachers and future teachers could reflect, evaluate, solve problems or exchange ideas (Pawan, Paulus, Yalcin & Chang, 2003) is the collaborative discussion boards.

4.5 Method and tasks

Case studies provide an opportunity for in-depth exploration of a specific learning activity in action (Stake, 1995). Adopting triangulation and a multiple-case study approach (Stake, 2006) may provide an adequate research strategy for addressing the potential impact of MMOL platform on training future on-line trainers and tutors. We chose two significant cases, each one with two experiences conducted in two different learning platforms: 2D vs. 3D. Both cases consisted of a collaborative Learning Object evaluation based on Learning Object Review Instrument (LORI) with the Convergent Participation Model (CPM) to determine the quality of e-learning resources. The Learning Object evaluated was the same regardless of the platform (MMOL or Moodle), namely a website on the history of books called *'Historia del libro'* (http://www.ite.educacion.es/w3/novedades/dossiers/libro/) (Fig. 10).

Figure 10. Evaluated Learning Object

4.5.1 Case "A"

Case "A" included students enrolled in a Master Degree Program about technology-mediated learning and teaching at the University of Alcala during spring 2010. To date, this Master's has been taken by over 100 students from Spain and Latin America. It is a two year on-line program with no face-to-face contact except for an initial presentation intended to help students become familiar with the use of the platform. This study focuses on eleven part-time, second-year mature students who participated in both experiences: LCMS and MMOL. Students were under no obligation to take part in the study, but once they expressed their interest, an analysis of their skills was carried out to determine homogeneous interaction patterns between members. As the experiences went on, efforts were made to ensure that the students had the same perceptions and ideas of LORI and Convergent Participation Model. The research used online surveys, log events, direct observations and triangulation to collect data analyzed with SNA. The first experience was with the LCMS Platform, the second with the MMOL platform.

As far as the LCMS was concerned, the students possessed good knowledge of Moodle as regular advanced users of this tool. The learning experience was devised to produce structured asynchronous activities which functioned as LORI collaborative evaluation conducted by an elected on-line tutor. The students were free to choose their role: reviewer alone or on-line tutor and reviewer. Three students chose to be on-line tutor. To create similar opportunities for tutor election the students had a prior forum presentation. The elected tutor guided the evaluation experience for one week. The learning activity design included the elements related above.

The experience began with an introduction to the activity in a forum post, where the tutor introduced the most relevant aspects, presented the timetable and answered questions from the learners. This was followed by other forum posts explaining the collaborative evaluation procedure and the beginning of the experience. For two days the students were sent to the specific discussion forums their individual LORI item valuations. After that and for another two days each student commented and reviewed the evaluation of the other classmates. Discussions between participants were moderated and conducted by the on-line tutor in order to unify their arguments (Convergent Participation Model).

The experience concluded with a last forum post published by the tutor with the final LORI item valuations accepted by the group. At the beginning and the end of the experience individual learners were asked to complete an online survey. The interactions between participants were registered in a log events file.

As far as the MMOL platform was concerned, the participants had no previous experience, but most had an acceptable knowledge of video-gaming and other similar 2.5D environments. For this reason, they were only given a 90-min initial session to learn about the realXtend viewer functionalities and interface. This session was also used for their in-world presentation to the group. After two days the students were called to a second 90-min meeting conducted by the elected on-line tutor. The storyboard of the session was an introduction to collaborative evaluation procedure (5 minutes), individual LO evaluation (20 minutes), collaborative LO evaluation (30 minutes), Convergent Participation Model (20 minutes), general acceptance (10 minutes) and any other business (5 minutes). The learning design of this meeting included the elements and resources related above, for example: live chat, co-browsing viewer, in-world shared spread-sheet, in-world shared presentation, etc. As in the previous experience, at the beginning and end of the meeting individual learners were asked to answer an online survey. The interactions between participants were registered in a log events file.

4.5.2 Case "B"

This case included ten student research assistants enrolled in the Information Engineering Research Unit of the University of Alcala (http://www.ieru.org/) and was carried out in fall 2010. IE is a research group in the Computer Science Department that has extensive expertise in the areas of learning technology (IMS-LD, SCORM), implementation of learning technology interfaces (OKI), semantic Web using ontology languages like OWL or WSML, data mining (Weka) and social network analysis methods and tools (especially Pajek). The voluntary participants were all over 18 years old and shared similar characteristics and knowledge as in Case "A". As there, they became involved in both experiences: LCMS and MMOL. As there too, in the course of the research experiences efforts were made to ensure that the volunteers had the same perceptions and ideas about the collaborative evaluation task. The research used online surveys, log events, direct observations and triangulation to collect data analyzed with SNA. The group of participants was studied previously in order to determine homogenous interaction patterns between members. In this case the order of experiences was altered: now the first experience was with the MMOL platform, the second with the LCMS Platform. This time, the preparatory session about the MMOL platform also helped us to elect the on-line tutor from among participants after their in-world presentation to the group. The participating students explained their on-line tutor skills with the aid of shared in-world presentations. Two learners chose to be on-line tutor and finally one of them was elected by a show of hands. Otherwise both experiences were carried out with the same characteristics, storyboards, elements and times as in the previous case. The initial surveys of both experiences allowed us to conclude that all volunteers were advanced users of Moodle and that none had experience in MMOL platforms (Fig. 11).

Figure 11. Researchers participating in the MMOL platform experience

4.6 Results and discussion.

Studying and evaluating real experiences that promote active and immersive education learning is a crucial issue in distance learning. MMOL platforms have introduced new challenges to evaluation, some of which are related to synchronous and asynchronous learner interactions. In the case of the experiences reported in this paper, the evaluation is especially complex because we try to compare two different environments: LCMS vs. MMOL platforms. In order to obtain significant and meaningful results, the method proposed in this section aims to yield a mixed evaluation combining on-line surveys (Appendix B), log events and direct observations with data analysis and social network analysis in a holistic interpretative approach. Figure 12 represents this evaluation method.

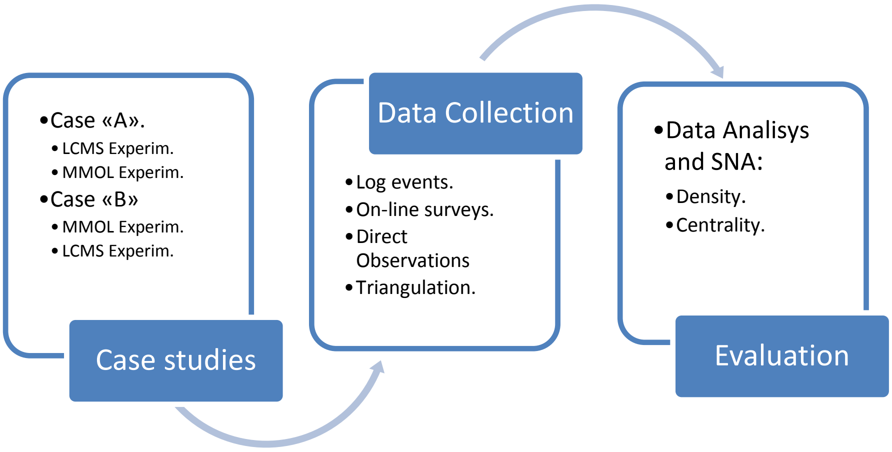


Figure 12. Evaluation method

SNA techniques allowed us to study how learners participate and interact with each other and, more particularly, student–tutor interactions. This in turn provides information about the activities of such a community and the way they learn collaboratively. The two platforms selected generate log-files from which information about member activity can be obtained. The in-world/out-world direct participants' observations complete the sources for data collection and permit the values of the surveys to be confirmed or disconfirmed. The information retrieved from platforms, survey responses and direct observations can be treated as relational data and stored away in a case-by-case matrix to analyze interaction patterns and the strength of the relations (Scott, 1991). These relations were considered directed and values. The case-by-case matrix values were adjusted with a triangulation technique that facilitates data validation through cross verification from different sources. For this purpose we focused on the cohesion of the network (Wasserman & Faust, 1997) based on messages or dialogs interchanged between participants, the personal perception of relationships with others, and direct observations. As the emphasis should be on the responsive nature of the communication, we focused on analyzing structures of responsiveness relations between participants (Aviv, Erlich, Ravid, & Geva, 2003).

The first indication of network cohesion is density. Density describes the general level of linkage among the nodes in a network. The density of a network is defined as the number of arcs in a network divided by the maximum number of all possible arcs (Scott, 1991). The density is at a maximum when all the nodes are connected to each other.

Another relevant network cohesion feature is centrality, the identification of the central participants within the network, i.e., the structural importance of a node. In our study it was very important to determine the position of the on-line tutor in the collaborative evaluation process. For each participant this was done using both Freeman's degree and betweenness. Freeman's degree measures the network activity of the participants, that is, the proportion of all the others with whom they communicate. Since we know the nature of the relationship between the participants, i.e., who interacts with whom, the directed arcs specify the orientation of the relationship. This question is of especial interest for the centrality measures as well as for the creation of the sociograms. In a directed case-by-case matrix, a participant can be either adjacent to or adjacent from another node depending on the direction of the arc (Wasserman and Faust, 1997). This means that we can consider these cases separately by differentiating the in-degree and out-degree centrality measures. In-degree centrality is a form of centrality that counts only those relations with a focal individual reported by other group members, and is therefore not based on self-reports unlike out-degree centrality. In our study, in-degree measures provided information about how others assess relationships with a certain participant. Out-degree centrality gives an indication of how a person values their relationship with other individual members of a network. Both measures range between 1 (minimum) and 5 (maximum). These data were contrasted with data collected from other sources. Freeman's betweenness value shows how often a given participant is found in the shortest path between two other participants, this betweenness therefore telling us about the participant's possibility of regulating information flow within the community (Wasserman and Faust, 1997). A participant in such a position in the network is called a broker or a gatekeeper. High betweenness values indicate the extent to which a participant could play the role of a broker or gatekeeper.

4.6.1 Results

Data analysis and social network analysis were carried out with the aid of UCINET (Borgatti, Everett and Freeman, 2002). The first measure is density. The density values of Case "A" and Case "B" with the LCMS and MMOL platforms experiences show the overall connection between the participants (results shown in Table 3).

Density	LCMS Experience (X)	MMOL Experience (Y)	Difference: (Y−X)
Case "A"	0.3691	0.5182	0.1491
Case "B"	0.3222	0.5073	0.1851
Average	0.3456	0.5127	0.1671

Table 3. Density values of case studies. The last column shows the density increase trend when MMOL is used.

There seems to be a clear difference between the MMOL and LCMS experiences. First of all, the density values of MMOL are higher, indicating that the participants have more connections amongst themselves. Secondly, the density values of both experiences remain stable throughout the two case studies, while the average values rise from 34.56% to 51.27%, indicating that the number of connections between the participants increases when the MMOL platforms are used. Similar results for the LCMS experience have been found by other researchers studying network learning with groups of similar size and in asynchronous learning settings (De Laat, 2002; Martínez, Dimitriadis, Gómez, Rubia and de la Fuente, 2003; Aviv et al., 2003; Reffay and Chanier , 2003; De Laat, Lally, Lipponen and Simons, 2007).

To calculate centrality, in-degree and out-degree centrality values need to be obtained for each student (see Tables 2 to 5) first. These indexes emerged from discussion or dialogs threads in both platforms and responses to the on-line surveys, and from direct observations for each case and experience.

The results yield the visual representation of the learning network (see Figures 13 to 16). Also, in the MMOL platforms we considered the observed gestural postures, gazes and movements. Thus, for instance, in Case "A" student number 1 (elected tutor) was the participant with greater activity in both experiences: 26 messages sent in the LCMS and 35 dialogs, gazes or gestural postures in the MMOL platform. As for in-degree index, this student was not the most significant participant in LCMS experience, although he was the highest valued by peers in the MMOL experience. Student 1 assessed contacts with others in both experiences as follow:

	St A2[8]	St A3	St A4	St A5	St A6	St A7	St A8	St A9	St A10	St A11
LCMS	2	3	3	4	2	2	2	2	3	3
MMOL	5	2	3	4	2	2	3	3	4	3

Table 4. St A1's contacts with other participants.

The other participants assessed their relationships with Student 1 in both experiences as follows:

	LCMS	**MMOL**
St A2	2	3
St A3	2	4
St A4	2	4
St A5	3	4
St A6	3	4
St A7	3	4
St A8	4	4
St A9	3	3
St A10	2	5
St A11	2	4

Table 5. Other participants' contacts with St A1.

[8] Here and throughout this chapter the participants' name has been substituted by the abbreviation "St", the case letter and a number.

CASE "A"											
	St A1[9]	St A2	St A3	St A4	St A5	St A6	St A7	St A8	St A9	St A10	St A11
LCMS Experience											
In-degree	26	19	24	22	23	18	29	19	17	21	25
Out-degree	26	20	20	21	24	21	22	22	22	21	22
MMOL Experience											
In-degree	39	23	27	28	27	22	31	32	29	31	30
Out-degree	31	29	26	27	29	28	29	30	29	27	29

Table 6. In-degree and out-degree for all participants in Case "A" and both experiences.

CASE "B"										
	St B1	St B2	**St B3**	St B4	St B5	St B6	St B7	St B8	St B9	St B10
LCMS Experience										
In-degree	24	22	23	21	18	16	19	23	28	22
Out-degree	22	19	29	23	23	16	23	21	20	20
MMOL Experience										
In-degree	24	22	35	22	29	18	19	23	29	30
Out-degree	24	26	37	23	23	21	25	24	24	24

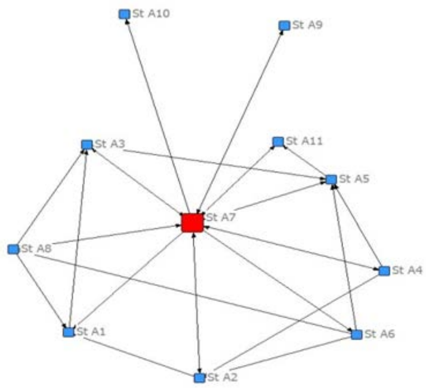
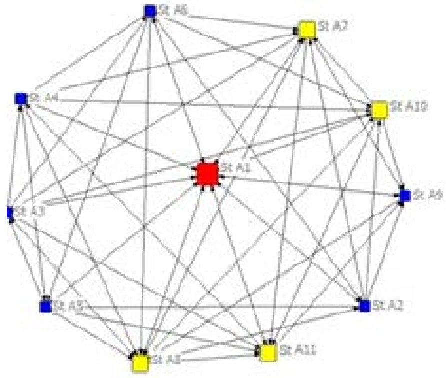
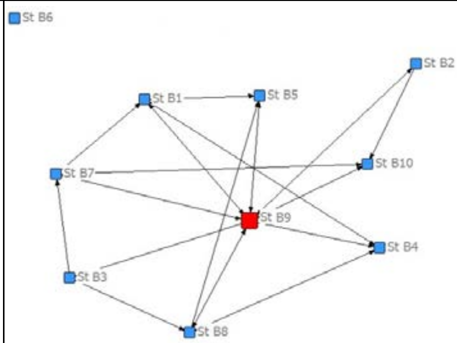
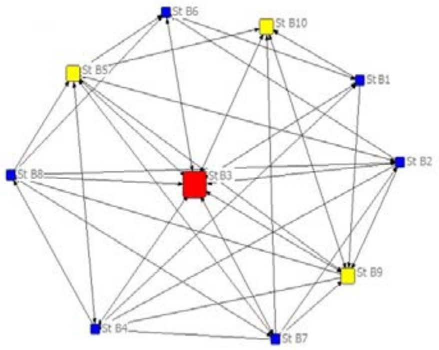
Table 7. In-degree and out-degree for all participants in Case "B" and both experiences.

Maximum
Minimum

The tables above provide a rapid impression of how the tutors are situated with respect to the relationships with learners. In the MMOL experiences, the tutors have the maximum values of in-degree and out-degree indexes in both cases, as can be seen in the respective columns of Tables 5 and 6. All data indicate a significant enhancement in quality relationships between group members (in particular with the on-

[9] Underlining denotes elected on-line tutor in all tables and figures.

line tutor) when the MMOL platforms were used. To be more precise, in case "A" (first column of Table 6) the in-degree and out-degree increments are 13 units and 5 units respectively. In Case "B" (third column of Table 7), in-degree and out-degree increments are 12 units and 8 units respectively. The results seem to be consistent across the experiences, and the visual representation of the learning network shows how the on-line tutor is situated in the network in a central position (see Figs. 15 - 18).

	LCMS Experience	MMOL Experience
Case "A"	 **Figure 13. Distributed-fragmented e-learning structure. St A10 and St A9 are nodes with poor relationships.**	 **Figure 14. A diamond shape denotes a distributed-coordinated e-learning structure. The red node represents the elected on-line tutor. Yellow nodes have high betweenness.**
Case "B"	 **Figure 15. Distributed-fragmented e-learning structure. St B6 is totally disconnected. Blue nodes have poor relationships with others.**	 **Figure 16. A diamond shape denotes a distributed-coordinated e-learning structure. The red node represents the elected on-line tutor. Yellow nodes have high betweenness.**

We use the terms '*Distributed-fragmented e-learning structure*' to label Figures 15 and 17 (LCMS experience) because they show that some students became removed from many of the day-to-day workings of the group; this was the case of students A10, A9 and, worst of all, B6.

Their lack of participation in the group resulted in disconnections which impacted the rest of the group. In contrast, Figures 16 and 18 (MMOL experience), labeled '*Distributed-coordinated e-learning structure*', illustrate a denser grid topology in which everyone is connected to each other. This means that information interchanges are more effectively channeled and distributed within the group. In relation to Freeman's betweenness value, in all cases the tutor's betweenness value was higher than 23%, so the tutor was the participant with the best chance of regulating information flow within the community. As we said above, the MMOL tutor was the participant with most connections with peers. Other participants in the MMOL experience with a significant number of connections were A7, A8, A10, A11, B5, B9 and B10. Also, the tutor's node has the shortest distance paths between its vertex and all reachable vertexes. Therefore, in all cases the MMOL tutor is characterized by a high betweenness value, the shortest distance path with peers, the highest in-degree and out-degree index values, and the maximum number of connections, which means that this participant played the part of a broker, 'hub' or leader.

The other participants' betweenness indexes show how the MMOL platforms supplied a more homogeneous social network where the actors were involved in a greater number of interchanges and peer interaction. In all cases we found more users' betweenness values to be above zero when we used the MMOL platform, to be more precise, 84% and 71% in Cases 'A' and 'B' respectively. In contrast, the LCMS Platform experiences gave an average value of 47%. Hence, using the

MMOL platform meant that there were fewer isolated individuals and greater interaction between users, since there are more paths between nodes.

The results seem to be consistent with the survey responses (see Appendix B). As shown in figures 19 - 20, the participants thought that the MMOL experiences offered a rich context of multi-user interactions between peers and tutor, and that MMOL platforms were a useful tool for tutor's tasks and collaborative assignments like the Convergent Participation Model. Also, the participants rated the informal and formal learning in virtual world context as much more fun than 2D contexts.

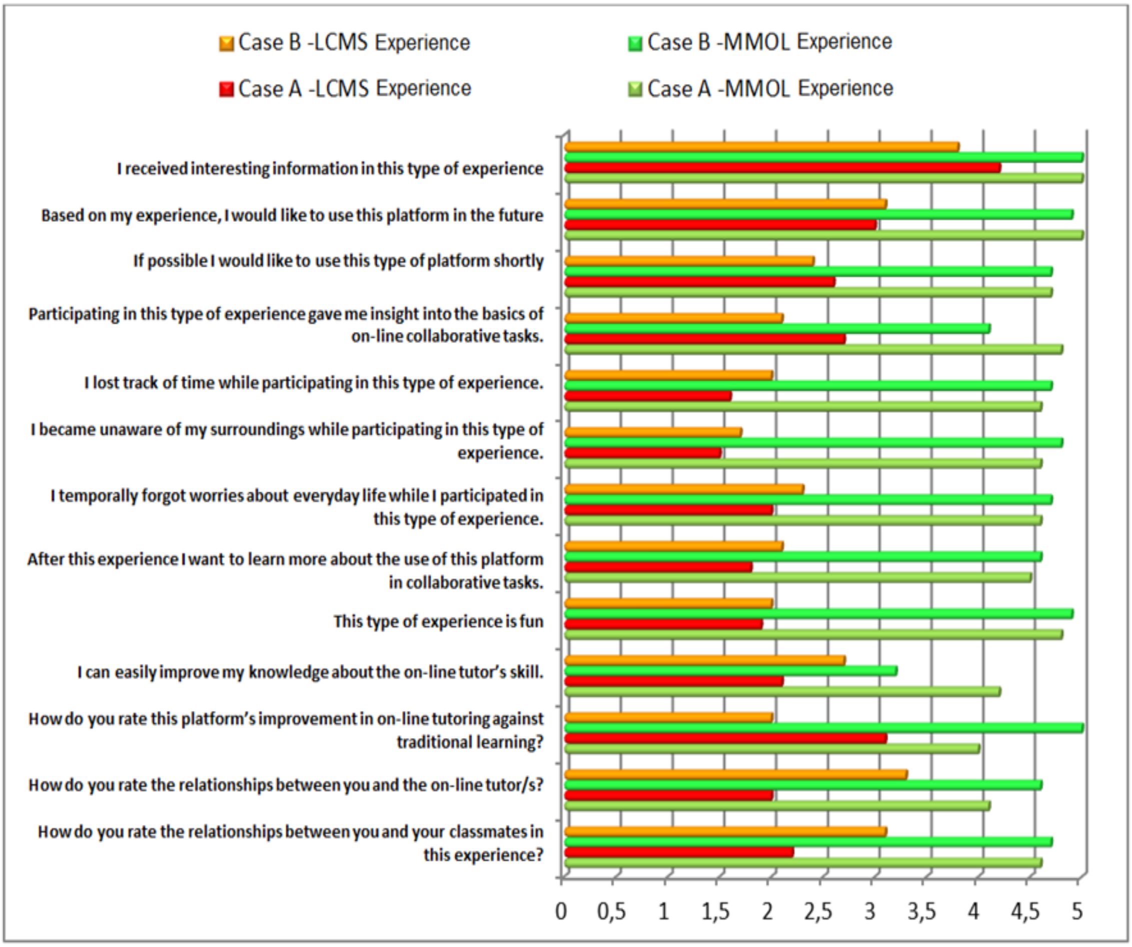


Figure 17. Survey responses by case and experience

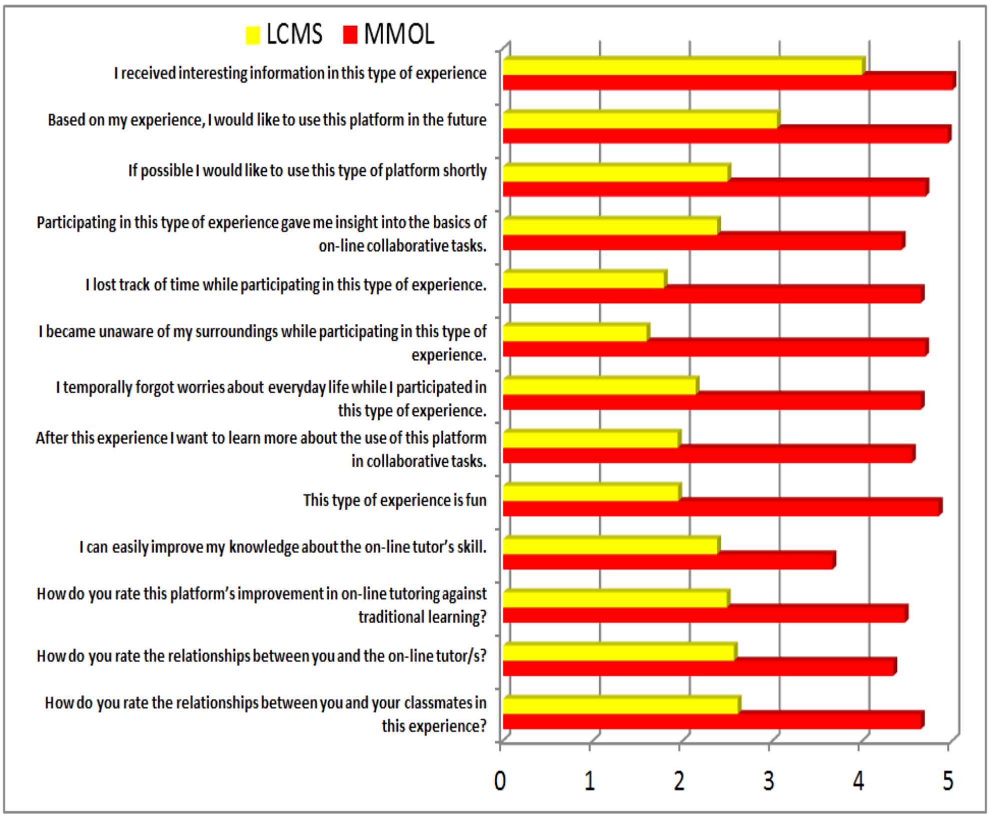


Figure 18. Survey responses by experience

4.7 Conclusions

The collaborative evaluation of learning objects is an instance of a collaborative task. The findings from this study suggest that MMOL platforms can provide better support capabilities for barrier removal between students and between tutors and students. This new learning context provides an interactive learning space with the use of 3D, 2D or 2.5D technologies to build collaborative and ongoing online environments and classrooms in which individuals participate in a real or figurative presence (avatar). Measurements taken from social network analysis, surveys, logs and direct observations help identify tutors as the most prominent actor in these collaborative communities. They play a major role in team coordination, as well as management and information sharing. The interaction patterns among participants make evident more connections between all nodes. In a dense network, as is the case of the MMOL experiences, many participants have connections with each other, and members are likely to influence each other mutually. Knowledge, ideas, and advice are distributed among many participants with the help of a clear broker, "hub" or leader. We have found evidence confirming the hypothesis that MMOL platforms offer the chance for more intense participations among group members than traditional asynchronous settings based on conventional LCMSs. As far as the specific task evaluated is concerned, we can conclude that MMOL platforms appear to be more appropriate for putting into practice learning experiences like the Convergent Participation Model.

However, it is still necessary to consider how these possibilities depend on factors such as suitable training in the virtual context, the adoption of a correct pedagogical framework, and the use of an adequate virtual world server, 3D learning objects, scenarios and storyboards.

Chapter 5. *Case Two. Teacher skills improvement in Diversity, Equality and Inclusion: Simulated-Based 3D Learning.*

5.1 Introduction

According to Bridger and Shaw (Bridger and Shaw, 2011) education is at the heart of any strategy for values-building. It is through education that the broadest possible introduction can be provided to the values, skills and knowledge which form the basis of respect for others, equality, the rejection of violence and a spirit of tolerance, understanding and mutual appreciation among individuals, groups and communities. Issues such cultural diversity, values education and students' diversity are essential to achievement of these educational goals (Lorenzo et al., 2011). However, some authors also argue that professional knowledge appears to be missing in the domain of these issues among teachers. In accordance with Thornberg (Thornberg, 2008) diversity is (a) most often reactive and unplanned, (b) embedded in everyday school life with a focus on students' everyday behavior in school as a constantly ongoing informal curriculum, and (c) partly or mostly unconsciously performed by the teachers.

In the context of secondary education, adjustment to these main issues is some of the major concerns of teachers, tutors, managers, parents and educational institutions. Educational needs of high ability students, restoring classroom discipline, non-discrimination, solidarity, harmony, special educational needs, etc. are activities in which much effort is put without achieving, in many cases, the expected results. The search for workable and lasting solutions by both teachers and institutions is complex because of lack of proper training. In order to find solutions to these problems, educational resources specially targeted for teachers and students constitute an important asset. Educational virtual worlds or MMOL platforms can be hypothesized to become an adequate context for these kinds of educational concerns. Specifically, education regarding values, conflict and diversity require a consideration of a number of issues with a special concern for attitudinal elements. This study raises a combined approach about the e-learning concerns based on a joint use of online role play and simulation. In the e-simulation one student adopts a role to interact with a computer. In the online role-play students adopt a role to interact with each other via the computer. Online role-play provides a scenario for the action and a set of roles that participants adopt in order to solve a problem collaboratively, create something new, or explore an issue (Wills, 2012). Consequently, on-line role-play in combination with educational simulation building on MMOL platforms could provide more possibilities for further training in theory and practice of these attitudinal elements, usually involving the following:

a) Discrimination of problems and cases.
b) Simulation of scenarios in which these situations show.
c) Establishment of channels that allow the control of its management, and the creation of agreements for conflict solving in tune with the culture and the characteristics of each institution.
d) Improving abilities and skills of teachers by means of training in the virtual world.
e) Better knowledge of attitudinal, behavioral and learning problems, as well as typical learner's roles.
f) Identifying those factors that originate the appearance of conflictive and troublesome situations.

In this sense Saunders (Saunders, 2007) emphasizes that virtual world based applications provide substantial improvements in aspects such as the communication skills of participants, methods of problem-based learning or exploratory learning experiences. Simulations also allow people to explore phenomena that may be excessively fast, slow, expensive, time-consuming, or dangerous (Snir, Smith, & Grosslight, 1993). Moreover, Angehrn (Angehrn, 2006) points how computer-enhanced approaches and simulation-based learning experiences have emerged to-date which address efficiently and effectively the development of collaboration competencies from an inter-disciplinary perspective, including:

- Individual psychological and motivational factors determining knowledge seeking and behavior sharing of people involved in collaboration.
- Group, organizational and inter-organizational factors conducive to collaborative behavior.
- Cognitive and behavioral mechanisms to support effective knowledge exchange processes in order to seek and integrate knowledge from diverse sources taking into consideration their contextual embeddedness.
- Opportunities and pitfalls of technologies aimed at supporting distributed collaboration.
- Pragmatic aspects resulting from the analysis of best/worst cases and experiences of collaboration patterns in different contexts.

Indeed, in today's context of a globalized world, a very large number of collaboration initiatives fail to reflect this trend. The complexity of school-community collaboration processes is significantly increased through the diversity and the distributed nature of the people, groups, and knowledge sources, thus MMOL platforms, from a role-based perspective, could provide adequate support for such distributed processes. This should lead to better tools to analyze and know teachers' skills and competencies development. Research of new pedagogical instruments, mainly based on the use of technology-enhanced resources, contributes with this approach. In this sense, the incorporation of online tools, or specific software, like MMOL platforms, where it is possible to generate virtual or augmented reality simulations and role-play activities, is attracting particular interest. The use of these platforms requires teachers training. In addition, teachers must become participants in immersive learning experiences and role-playing exercises.

By reviewing the trends in research and implementation of educational simulation, this review shows the absence of studies on the use of educational simulations together with on-line role-play in diversity concerns. This case study provides the framework for the identification of simulation-based learning foundations applied to teachers' training role-play activities based on scholar real-life diversity situations.

5.2 Issues of diversity in education and MMOL platforms

According to a European Commission study on the education of immigrant workers' children, the reality of current European societies, now and in the immediate future, is that a variety of ethnic groups, nationalities and communities, with their own distinctive lifestyles and value systems, will be living together (European Commission, 1995). The aims of diversity in education is to help students understand and appreciate cultural differences and similarities and to recognize the accomplishments of diverse race, ethnicity, gender, sexual orientation, language, culture, religion, mental and physical ability, class, and immigration status (Jover and Reyero, 2000; LAS, 2004). It is a practice that hopes to transform the ways in which students are instructed by giving equal attention to the contributions of all the groups in a society. A curriculum of diversity strives to present more than one perspective of a cultural phenomenon or an historical event. It prepares all students to work actively toward structural equality in organizations and institutions. The long-term goal of cultural diversity is to achieve the genuine inclusion of learners in a pluralistic society.

Cultural diversity is one of the main issues of diversity. Wainman (Wainman, 2000) notes that the nature of multi-cultural education has not always been clearly defined, but some key aspects have been established which include that it should be for learners in all schools, and that it should thus enable learners to appreciate the diversity of cultural experiences available to them. There are two main ways in which such education can be addressed in schools. First, schools can attempt to respond to the cultural requirements and sensitivities of children and parents from various ethnic backgrounds, promoting respect for religious and cultural beliefs. They could also aim to make educational use of the experiences they bring to the school. In this sense, the use of MMOL platforms allows teachers and schools to easy access to resources it needs in order to develop these cultural and ethnic experiences. Immersive educational contexts advocate the belief that students and their life histories and experiences should be placed at the center of the teaching and learning process and that pedagogy should occur in a context that is familiar to students and that addresses multiple ways of thinking. To accomplish these goals, teachers and virtual world expert’s designers must capable of including and embracing families and communities in a realistic virtual context to create an environment that is supportive of multiple perspectives, experiences, and democracy.

One of the most prolific scholars in diversity in education is James Banks. Banks (Banks, 2001) has analyzed the issue of cultural diversity in more detail and has described five areas in which teachers and researchers are involved:

– Content integration: Concepts, values, and materials from a variety of cultures and or individuals are included in teaching. The use of 3D objects, MOLs and RMOLs diversity related could help teachers to a rapid development of required virtual world.
– Knowledge construction: This belief asserts that all knowledge is created in the minds of human beings and can, therefore, be challenged. A critical part of diversity, the idea that knowledge is a human construct challenges teachers to alter their own perceptions of the world before they can teach. In this context, it is critical to ensure that teachers training simulations and role-play activities will be available for all those involved in a diversity child's education in order to accommodate their perceptions.
– Equity pedagogy: Teachers must modify their methods of instruction by allowing for students' cultural, social and individual differences before they can encourage

academic achievement. MMOL platforms can also help teachers to well-known in advance these differences and, hence, to plan academic achievements. As set out below, we propose the use of the standards for effective pedagogy that we can apply to these activities (Tharp, Estrada, Dalton, and Yamauchi, 2000).

- Prejudice reduction: Teachers must work to shift students' prejudices regarding race, ethnicity, religion, gender, mental and physical ability, etc. Prejudice reduction may also encompass teaching the tolerance of various religions, sexual preferences, disabilities, etc. The role-play activities on MMOL platform help to eliminate prejudices and to explain why these prejudices appear.
- Empowering school culture: Schools must identify those aspects of education that hinder learning and then empower families and students from all backgrounds, so that the full development of students is achieved. Teacher and learners training simulations in conjunction with role-play activities could be the key to identify problematic trends early.

5.3 Resources and settings.

5.3.1 Identifying Educational Diversity Activities: A Framework.

The educational framework described herein was created by Ford and Harris (Ford and Harris, 1999). They relied extensively on the models of Banks (Banks, 1994 and 2001) and Bloom (Bloom, 1956). Ford and Harris intersected or connected what have, heretofore, been parallel curricula models in education. Bloom's Taxonomy (Bloom, 1956) comprised six levels of thinking. This classification is often dichotomized as "low level" (knowledge, comprehension, and application) to "high level" (analysis, synthesis, and evaluation) as show in Table 8 (Ford, Moore and Harmon, 2005).

Level	*Description*	*Possible Products*
Knowledge	Students learn facts and basic information; rote learning.	Repeat, list, restate, etc.
Comprehension	Learners demonstrate their understanding of what has been taught; they explain; retell in their own words.	Define, recall, retell, paraphrase, etc.
Application	Learners use the information learned, learners apply learning.	Chart, draw, timeline, graph, etc.
Evaluation	Learners critique, judge, research topics, issues, events, etc.	Study, survey, give opinion with support, etc.
Synthesis	Learners combine events, ideas,	Song, cartoon, book,

	etc., to make something new or unique, to make a new whole.	simulation, poem...
Analysis	Learners examine, analyze, compare and contrast, predict, consider pros and cons.	Literature review, opinion, Venn diagram, etc.

Table 8. Bloom's Taxonomy: Description and Possible Products.
(Adapted from Ford et al., 2005)

Banks (Banks, 1994) identified four levels of ways to infuse diversity content into the curriculum (see Table 9).

Approach	Description
Contributions	Heroes, cultural components, holidays, and other discrete elements related to diverse groups are added to the curriculum on special days, occasions, and celebrations.
Additive	Content, concepts, themes, and perspectives are added to the curriculum without changing its structure
Transformation	The basic goals, structure, and nature of the curriculum are changed to enable students to view concepts, events, issues, problems, and themes from the perspectives of diverse groups. Students become more empathetic by viewing events from multiple perspectives.
Social Action	Students identify important social problems and issues,

	gather pertinent data, clarify their values on the issues, make decisions, and take reflective actions to help resolve the issues or problem

Table 9. Banks' Four Approaches

At the lowest level, the Contributions Approach, teachers focus on heroes, holidays, and discrete elements. This is the most frequently adopted and extensively used approach to diversity in general and in cultural diversity in particular, yet it is the most simplistic. In this approach, the traditional ethnocentric curriculum remains unchanged in its basic structure, goals, and salient characteristics. Frequently, cultural traditions, foods, music, and dance may be discussed, but little or no attention is given to their meaning and significance to minority groups. Although ethnic content is limited primarily to special days, weeks, and months related to minority groups, students learn little to nothing about the occasion, group, or individuals being "celebrated."

In the second level, the Additive Approach, the content, concepts, themes, and perspectives of minority groups are added to the curriculum, but without being integrated throughout the curriculum. Thus, the basic curricular structure remains unchanged. For instance, teachers may add a diversity book or unit to one particular course, but not to another. This piecemeal approach does not help learners understand diversity concepts, issues, and groups in a coherent or systematic way. That is, while the content changes slightly, there is little restructuring of the curriculum relative to purposes and characteristics.

At Transformational Approach level, two transformations occur. First, the structure of the curriculum changes so learners are given opportunities to view concepts, issues, events, and themes from the perspectives of diversity. Second, there are changes relative to the fundamental assumptions, goals, nature, and structure of the curriculum. These two transformations provide learners with a critical awareness of, understanding of, and respect for diversity concepts, events, and people.

The Social Action Approach is the highest level. Here, learners make decisions on important social issues and take action to help solve them. Learners are not socialized to accept mainstream ideologies, practices, and institutions. Instead, they feel empowered and are proactive; they participate in social change because they have the knowledge and perspective to do so. Learner self-examination becomes central in this level because of attention to value analysis, decision making, problem solving, and social action. This approach is least likely to be adopted by teachers primarily because they lack formal training, experience, understanding, and personal knowledge of diversity (e.g., histories, values, beliefs, and customs). This approach and the Transformation Approach require substantive preparation, as well as time and commitment.

The main goal of educational simulations is develop realistic virtual world in order to build incremental experiences from Bank's and Bloom's lowest to highest levels (bottom-up) to promote a comprehensive approach. Educational simulations are school-wide instrument to support knowledge transfer in diversity and to favor teacher training programs. The framework described herein must always be an appropriate reference to implement the virtual context and to put in practice teachers' role-play activities.

5.3.2 Applying the Framework Using a Daily Event-Based Example.

The educational scenario, where this case study took place, was designed based on the working experience of several experts in the vocational and educational guidance area. School counselors developed an educational template that permits teacher to register real-life educational situations in the fields of diversity. A translated version of this template is showed in Table 10.

Daily event short name	
Date and Time	
Detailed description of the facts	
Detailed description of place: classroom, corridors, gymnasium, schoolyard, etc.	
Detailed description of objects in the scene. *(Please provide justification for the inclusion of each object)*	
List people involved in the daily event with a detailed description of personal relevant features: gender, ethnicity, language, nationality, sexual orientation, religion, etc. *(Please provide justification for the inclusion of*	

each person and his or her features)	
Detailed description of all qualities which make the event as a distinctive fact of educational diversity *(Please provide justification for the inclusion of each quality)*	.
Detailed description of all events and circumstances *(Please provide justification for the inclusion of each event)*	
Detailed description of all engagements to long term conflict resolution. *(Please provide justification for the inclusion of each engagement)*	
General comments	

Table 10. Scene description template.

This template was used for teacher participants in this case study to describe relevant situations of diversity during one scholar year, from September 2010 to June 2011. The aim of this fieldwork was the compilation of required documentation. This compilation has a dual function, on the one hand, to help the recreation of the virtual environment with all objects and resources identified by teachers and, on the other, to devise innovating and fun activities, and learning and training strategies based on Ford and Harris framework (Ford and Harris, 1999). Each activity was described in detail taking into account the next guidance:

a) General description.

b) Objectives.

c) Guiding questions/experiences using Bloom's cognitive taxonomy.

    c.1) Knowledge Level.

    c.2) Comprehension Level.

    c.3) Application Level.

    c.4) Analysis Level.

    c.5) Synthesis Level.

    c.6) Evaluation Level.

d) Guiding questions/experiences using the Ford-Harris Framework. Each cell serve as a guide for teachers; additional questions, statements, and activities can be added to meet the goals and objectives of each classroom or simulation. See Figure 19.

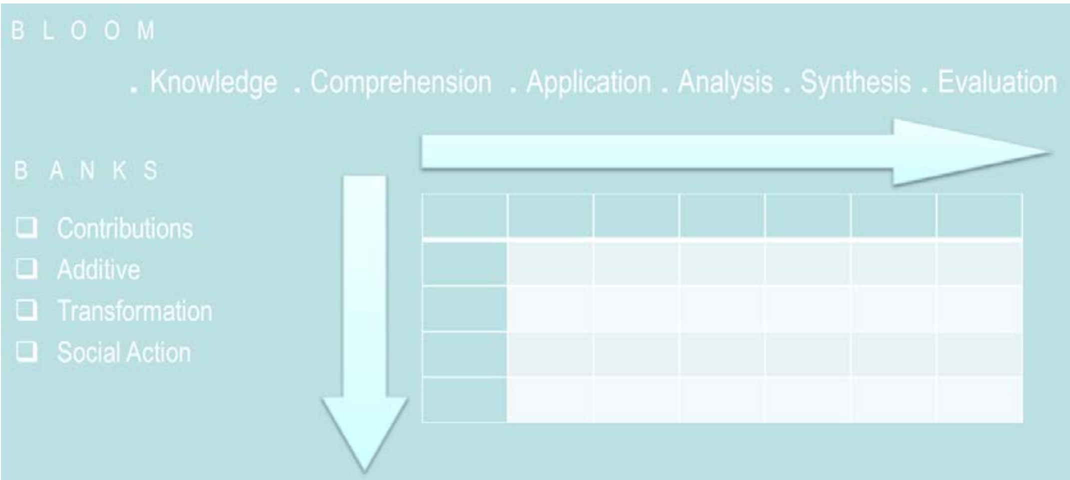


Figure 19. Ford-Harris Matrix

Teachers' feedback led to identify more than fifty activities based on daily events about diversity in education. Prominent examples are: Islamic headscarf use in classrooms, Latino gangs, school absenteeism, gender equality, contempt for other cultures and nationalities, etc.

5.4 Designing an Educational Simulation: Keys to Success.

Once the information was collected, and teachers devised activities and strategies, the next step is designing the educational simulations. Traditionally, simulations are something that bridges the gap between the typical classroom setting and the real world where actual practice occurs (Magee, 2006). The aim of educational simulations is to stimulate the creation of knowledge-centered mental models within the learner by having them discover concepts, rules and principles through experimentation. Some authors consider the problem of design educational simulations as a manufacturing process and describe a step sequence to obtain a product (Aldrich, 2005). Figure 20 shows one of the step sequences proposed by Aldrich.

Step 1.01: Identify and Build Buy-In for the Broad Need for Sims
Step 1.02: Identify the Area of Need
Step 1.03: Assign the Early Roles
Step 2.01: Identify Learning Goals and Program Goals
Step 2.02: Rigorously Identify Target Audience
Step 2.03: Create a High Level Budget and Time Frame
Step 2.04o: (Optionally) Bring in an Outside Vendor
Step 2.05: Produce Concept Document
Step 2.06: Produce Rough Schematic/ Walk Through
Step 2.07: Set up Sharing Infrastructure and Meeting Schedule with Stakeholders
Step 2.08: Review Existing Training Materials
Step 2.09: Research, including outside research
Step 2.10: Interview Subject Matter Experts
Step 2.11: Build out the Simulation Model
Step 2.12: Identify Genre, Platforms, and Techniques
Step 2.13: Synchronize and Mesh the Content Model
Step 2.14: Bring in the Final Programming Talent, if not yet done
Step 2.15: Bring in the Lead Artist
Step 2.16: Finalize Budget and Project Plan
Step 2.17: Establish Scenarios, Story, Characters, and Settings
Step 2.18: Break out Levels and Level Designs
Step 2.19: Create List of Needed Art
Step 2.20: Produce Proof of Concept
Step 2.21: Produce the Design Document
Step 2.22: Finalize Assessment Strategy
Step 2.23: Develop Architecture, including Content and SCORM and LMS Integration
Step 2.24: Finalize Key Simulation Actions and Mechanisms
Step 2.25: Meta-Code Algorithms
Step 2.26: Create all of the Final Illustrations
Step 3.01: Prototype in Code Each New Segment/Genre
Step 3.02: Complete all Dialogue and Pedagogy Text
Step 3.03: Build Out the Various Content Engines
Step 3.04: Create One Complete Level
Step 3.05: Finish the Separate Self-Contained Engines Pieces and Fill in the Level Details
Step 3.06: Combine Different Pieces into Seamless, Rough Whole
Step 3.07: Translate the Text
Step 3.08: Step Bring in the Final Acting Talent
Step 4.01: Pilot for Usability and Learning Objectives
Step 4.02: Rerecord talent where necessary
Step 4.03o: Find the Right Content (Optionally, if using third party sims)
Step 4.04: Package Any Support Material
Step 4.05: Create and Present Marketing Material
Step 4.06: Put on Final Server
Step 4.07: Chunk Content (for class use)
Step 4.08: Test Sim with a Subset of Final Population
Step 5.01: The Set Up (for class use)
Step 5.02: From Real Life to Simulation (for class use)
Step 5.03: Teaching the Interface (for class use)
Step 5.04: First Public Simulation Play (for class use)
Step 5.05: Putting together participants for Multiplayer or Team Based Sims (for class use)
Step 5.06: Coaching During the Student Use (for class use)
Step 5.07: After Action Reviews (for class use)
Step 5.08: Off Ramp from Simulations Back to Real Life (for class use)
Step 5.09: Gather Metrics around "Simulation Use and Effectiveness" in Full Population
Step 5.10: Create the Final Report
Step 5.11: Patch and update the Sim

Figure 20. Summary of Aldrich's approach steps.[10]

Other authors simplify the design process in order to build a personalized environment, speeding up development and trying out time. So, Null and Wysocki (Null and Wysocki, 1978) consider the following steps: (a) define the problem area to be simulated, (b) objectives and scope of simulation, (c) people and organization involved, (d) motives and purposes of the players, (e) resources available to the players, (f) transaction to be simulated and the decision rules to be followed, (g) formulate the evaluation method, (h) develop the simulation prototype, (i) try out and modify prototype.

Our study proposes a complementary approach which is founded on the educational dimension of simulations, learner point of

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[10] *Source: http://clarkaldrichdesigns.blogspot.com.es/2011/09/steps-in-building-simulation-or-serious.html*

view and role-based e-learning. That is why we mainly took ***activity centers*** as our starting point for designing and building educational simulations. Activity centers provide the context for a teaching transformation, as well as a means for promoting fairness, values education, cultural diversity, harmony, inclusion, and academic excellence. The aim of reorganizing a classroom into activity centers is to allow the teacher to provide the highest quality instruction to a small group of students, while other students work productively, independently, and cooperatively in a variety of interconnected tasks at other activity centers (Hilberg, Chang, and Epaloose 2003). The theoretical background is based on ideas of Tharp (Tharp et al., 2000) and Effective Pedagogy, who formulated five pedagogy standards for teaching and learning. Anyway, we do not propose Effective Pedagogy should be used to the exclusion of other strategies.

The first standard, Joint Productive Activity (JPA), involves teachers and learners working together on a common product or goal with opportunities to converse about their work. The second standard, Language and Literacy Development (LLD), involves developing competence in the language and literacy of instruction, as well as the academic disciplines, throughout all instructional activities. In our case this standard could be adapted to diversity subjects. The third standard, Contextualization (CTX), situates new academic content in contexts familiar to learners to connect it to prior knowledge or experience from home, school, or community. The fourth standard, Challenging Activities (CA), engages learners in complex tasks requiring the application or use of content knowledge to achieve an academic goal. The fifth standard, Instructional Conversation (IC), is to teach primarily through a planned, goal-directed conversation between the teacher and a small group of learners.

Activity centers can be located anywhere in the physical or virtual classroom, and almost any meaningful activity can provide the foundation for an activity center. Learners often work in small groups or with teacher to generate shared products, and at times it's also appropriate for students to work independently on skill-based, review or practice-level tasks.

Hilberg et al. note that there are two basic types of activity centers: (a) the teacher-led instructional conversation, IC center, and (b) the independent centers collaboratively led by peers. At the IC center the teacher engages in challenging tasks and instructional conversation with three to seven homogeneously-grouped students. At the independent centers, students work in heterogeneous groupings, independent of teacher assistance, following directions on a task card or instruction sheet. Activity centers become even more important in classrooms with learners from a variety of cultural, ethnic and language backgrounds (Hilberg, Chang and Epaloose, 2003).

To implement activity centers, it must be gradually established a planning whit the next phases:

- *Phase I*: the classroom community works to establish the routine of beginning each instructional activity with an opening, and ending with a closure to introduce and model behavioral expectations and community values, and to discuss and problem solve the activity.

- *Phase II*: teacher assists one section of the class while the other(s) practices working independently.
- *Phase III*: each learner has opportunities to work with all other learners in the class. Teacher routes learners through the activities in various patterns.
- *Phase IV*: attention shifts from logistics, behavioral expectations and community building, to academic content. Activity centers and routing patterns are stable for a period of time. Teachers continue to ensure that all learners are successful, and that all instructional activities are introduced in an opening, and problem-solved in a closure, also using these times for reinforcing classroom values.
- *Phase V*: learners continue to work in heterogeneous groupings at independent activity centers, and now also work in homogeneous groups at the IC center, where teacher engages students in instructional conversation.

The implementation of these phases enables the transformation of classroom from whole-class, teacher-centered instruction to activity center instruction, which is characterized by increased quality and quantity of student participation in complex tasks. Learners work in a variety of roles and in multiple grouping formats such as affinity, diversity, ability, gender, interest, and ability, both homogeneous, at the IC center, and heterogeneous, at the independent centers.

Following steps are adequate to create an instructional unit using activity centers:

a) Select the outcome or theme for the unit based on activities described in previous section, i.e., using Bloom's cognitive taxonomy and Ford-Harris Framework.
b) Break it into slices, relevant subsections, main concepts, or components.
c) Design one or more activity centers for each slice.
d) Design a detailed storyboard for each activity center as guide for simulations based on role-play activities described in previous section.
e) To assist learners keep track of work completed, create a Learner Activity Log for each unit.
f) Create an overview of the activity centers unit, similar to a syllabus, and provide it to learners. Include the goal(s), a brief description, and assessment criteria for each activity center.

5.5 Method and tasks.

Case studies provide an opportunity for in-depth exploration of a specific learning activity in action (Stake, 1995). Adopting triangulation and a case study approach (Stake, 2006) may provide an adequate research strategy for addressing the potential impact of

MMOL platform on training teachers in diversity issues and educational simulations.

5.5.1 Socio-demographic environment.

Cases under consideration include teachers located in public secondary schools of Guadalajara province (Castile-La Mancha, Spain). Social reality of this province is characterized by the arrival of a significant numbers of immigrants in the past decade, which had been gradually incorporated to the public education system, especially in primary and secondary levels. With the arrival of these newcomer students, teachers and education managers must face a changing context, closely associated with diversity that transcends the limits of the classroom. Newcomers came from the most varied places; highlighting Romania, Morocco and Ecuador (see Figure 21).

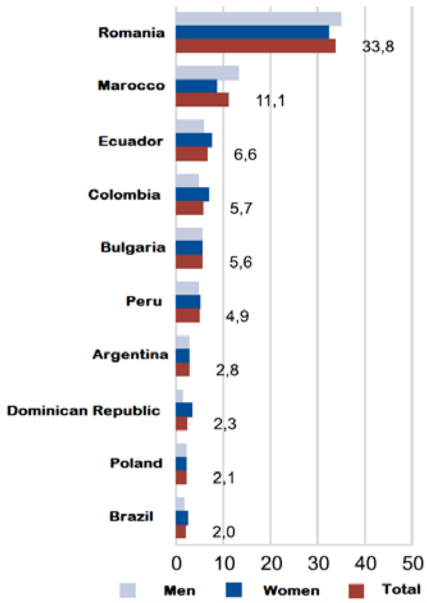

Figure 21. Immigrants' nationalities.
Source: INE[11] (Spanish National Institute of Statistic)

Province of Guadalajara is home to around of 240.000 inhabitants. About 15% of population is immigrant. The presence of an ever growing foreign population has led to social tensions, since the local population is not accustomed to live with different cultures and nationalities. The demographic changes occurring in the immigrant population demand an increase of educational and occupational guidance specialist, teachers, and resources. Demographic growth over past decades is showed in the next figure (Figure 22)

[11] Instituto Nacional de Estadística (http://www.ine.es)

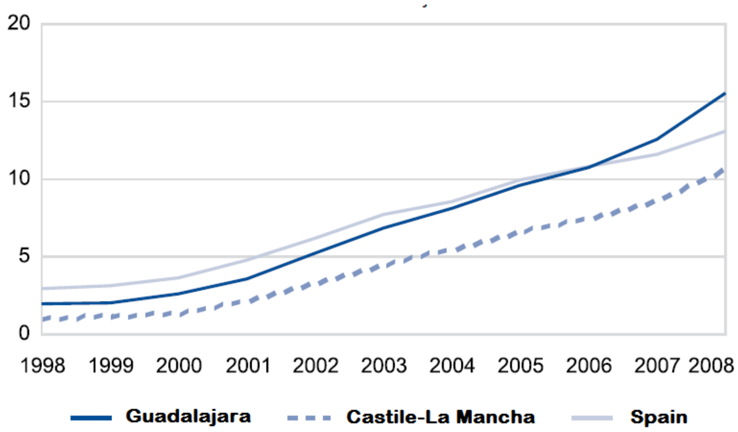

Figure 22. Immigrant population trend (1998-2008)

Source: INE (National Institute of Statistic)

The features of this new population could be summarized in the following points:

(a) Immigration includes whole family.

(b) Language barriers, Latin-Americans included.

(c) Close links with their community and culture.

(d) Strongly grouped by nationalities.

(e) Difficulty in taking on the values of other cultures.

(f) Certain level of school absenteeism.

(g) Strongly influenced by local leaders and popular figures.

(h) Youth population who demand attention by the education system and social care.

Foreign population pyramid is showed in Figure 23.

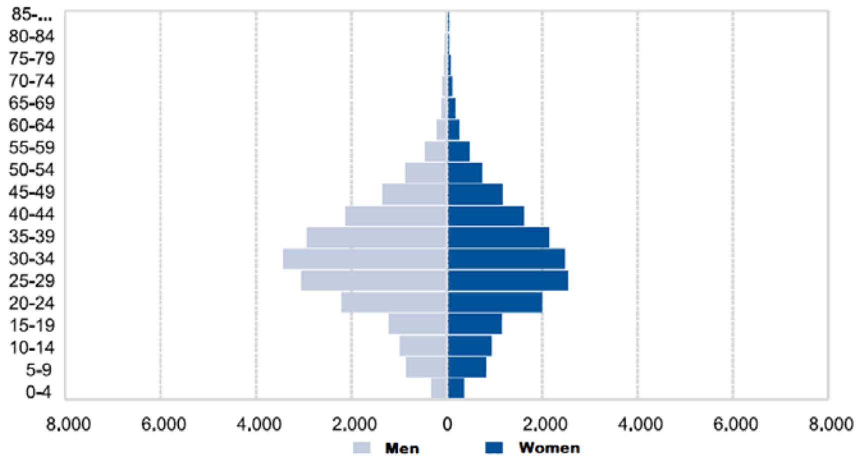

Figure 23. Immigrant population pyramid.
Source: INE (National Institute of Statistic)

Education in Spain is free and compulsory from the ages of 6 to 16, which is the minimum legal working age, although the free and compulsory nature may be extended to the age of 18 in ESO (Compulsory Secondary Education) for a variety of reasons: failed or missed school years, adaptation for foreign students, etc. The last two years of secondary education (*Bachillerato*) is not compulsory and learners ranged in age from 16 to 18 years. Students with learning difficulties have the possibility to study vocational training programs from 16 to any age.

5.5.2 Demographics

A group of two experts in the educational guidance field and twenty secondary school teachers of non-computer subjects that use computers regularly in their classroom were involved in this study. Their involvement in this study is framed within a seminar supervised by Teacher Training Center of Guadalajara – C.E.P. Guadalajara–. This center, dependent of the Education Department of the Regional Government of Castile -La Mancha., is charged with providing the necessary training for all primary and secondary school teachers located in Guadalajara. All teachers were under no obligation to take part in the study. An analysis of their skills was carried out to determine homogeneous interaction patterns between members. As the experiences went on, efforts were made to ensure that teachers had the same perceptions and ideas of diversity concepts, the issue of socio-demographic environment and Five Standards application. Teacher' years of experience ranged from 1 to 19 (M = 7.08 and SD = 6.54). All of them have immigrant students in their schools. Teachers were divided into two groups. The first group (RCGR) is comprised of ten teachers who carried out simulations and role-play activities in real classrooms and schools (i.e. without MMOL platform). The second group (VWGR) is comprised of the others ten teachers who performed experiences in a virtual world context (i.e. with MMOL platform). An initial preparatory session held in order to teach these teachers 3D environment and first steps towards building diversity-based activity centers with RMOLs. Researchers verified that all teachers have similar resources in both environments (real and virtual).

5.5.3 Case Study

Cases under consideration were carried out during one school year, from September 2011 to June 2012. With the assistance of diversity experts and school counselors, teachers defined a coaching process that includes three activity centers that recreated scene of action. The simulations' layout is showed in the next figure (Figure 24):

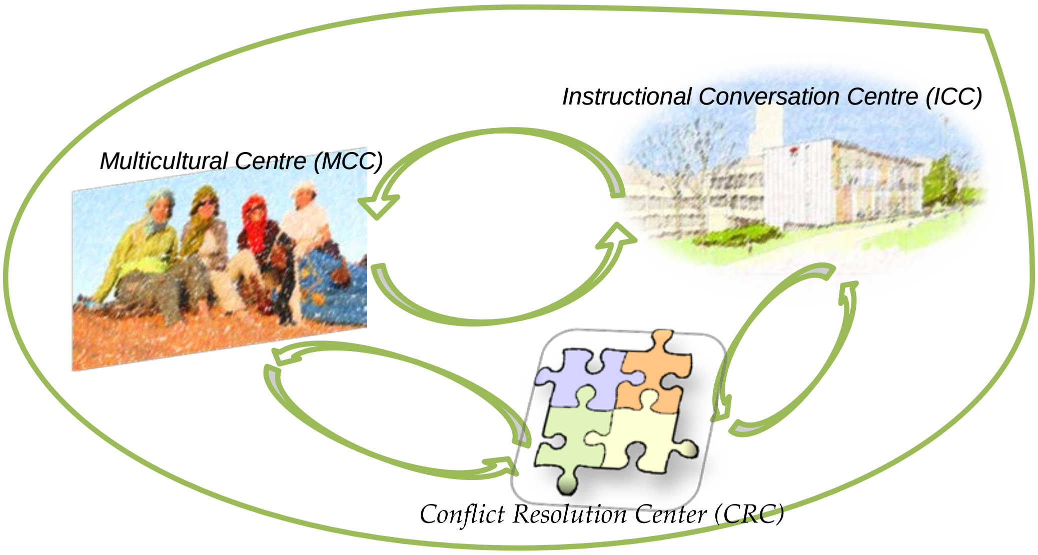

Figure 24. Simulations' layout.

Each activity center was designed from a threefold perspective:

a) Organizational perspective to distinguish between activity centers types: teacher-led instructional conversation center (TIC) or independent centers collaboratively led by peers (ICC).

b) Effective Pedagogy perspective to determinate standards applied: Joint Productive Activity (JPA), Language and Literacy Development (LLD), Contextualization (CTX), Challenging Activities (CA) or Instructional Conversation (IC).

c) Bloom's Taxonomy perspective to determine expected products and results, and activity levels: Knowledge

Level (KL), Comprehension Level (CL), Application Level (APL), Analysis Level (ANL), Synthesis Level (SL) or Evaluation Level (EL).

On that basis, a summarized description of activity centers is showed in the next table (Table 11).

		***Instructional Conversation Center* (IIC)**	***Multicultural Center* (MCC)**	***Conflict Resolution Center* (CRC)**
Organization		TIC	IIC	IIC
Pedagogy		IC	CTX + LLD	JPA + CA
Bloom's Taxonomy	***Level***	KL+CL	KL+CL+APL	ANL+SL+EL
	Results	Description, Definition, Report, Learning Object	Reproduction, Role-play, Learning Object	Panel, Action Plan, Learning Object

Table 11. Activity centers' matrix

Instructional Conversation Center (IIC) is where school counselors, as experts in the educational guidance field, present the case under consideration based on instructional units described in previous section using activity centers. In our case the themes or ideas to serve as a starting point to focus the role-play activities are:

1) ACU-1: poor school performance of Muslim students during Ramadan period, in part as a result of daily fasting.
2) ACU-2: European cooperation between schools to fight against exclusion and promote the concept of tolerance.

This project is developed in the scope of Comenius program, involving students of different ethnic and cultural backgrounds. The experience deals with the issue of tolerance and exclusion of the most underprivileged, by making students aware of other cultures and other countries through the organization of activities for exchange and dialogue as well as cultural and diversity events in different contexts.

3) ACU-3: Latin American youth gangs in Europe, their way of live, dressing, their behavior and relations between members.

IIC is characterized by a direct teaching, when necessary; experts provide direct teaching of a skill or concept. Discussion must be focused on questions for which there might be more than one correct answer. Experts promote teachers' use of text, pictures, expressions, gazes and reasoning to understand secondary students. They must provide teachers pertinent background knowledge and relevant concepts necessary for understanding a real-life diversity events. Experts should select a stimulus for beginning IC that encourages every teacher to talk about experience or background knowledge related to IC intent and topics. School counselors create a "Zone of Proximal Development" (ZPD) (Vygotsky, 1978), where a challenging atmosphere is balanced by a positive affective climate. Experts are more collaborator than evaluator and create an atmosphere that challenges teacher and allows them to negotiate and construct the meaning of the diversity event. Experts encourage general participation among teachers and do not hold exclusive right to determine who talks and teachers are encouraged to volunteer or otherwise influence the selection of speaking turns. From organizational perspective IIC is organized as a teacher-led instructional conversation center, where intend to develop mainly Instructional Conversation standard, as well as Knowledge and Comprehension Bloom's Levels. Outcomes are the construction of an effective knowledge through clear descriptions, definitions or reports about the diversity simulated issues. These outcomes were packed in a portable format, like SCORM object, for a subsequent review or training.

Multicultural Center (MCC) is the space for role-play experiences. The contents and objects of this area change over time as the needs of teachers. In the case of VWGR these elements were provided by expert designers as MOLs or RMOLs formats. From organizational perspective MMC is organized as independent center collaboratively led by peers, where teachers work in heterogeneous groupings, independent of experts' assistance, following directions included in the activity center unit and storyboard, abovementioned. Next table (Table 12) shows the teachers' roles adopted during the simulations:

Simulation	*Roles*	*Id*	*Participants*
ACU-1	• Muslim student (male)	R_11a/b[12]	2
	• Muslim student (female)	R_12	2
	• Romanian student (male)	R_13	1
	• Latin-American student (female)	R_14	1
	• Spanish student (male)	R_15	1
	• Spanish student (female)	R_16	2
	• Secondary teacher	R_17	1
ACU-2	• European student (male)	R_21	1
	• European student (female)	R_22	1
	• Moroccan student (male)	R_23	1
	• Moroccan student (female)	R_24	1
	• Latin-American student (male)	R_25	1
	• Latin-American student (female)	R_26	1
	• Spanish student (male)	R_27	1
	• Spanish student (female)	R_28	2
	• Secondary teacher	R_29	1
ACU-3	• Latin-American student (male)	R_31	3
	• Latin-American student (female)	R_32	2
	• Spanish student (male)	R_33	1
	• Spanish student (female)	R_34	2
	• Romanian student (male)	R_35	1
	• Secondary teacher	R_36	1

Table 12. Teachers' roles

From pedagogical perspective the main goal of this IIC is the implementation of Contextualization and Language and Literacy Development standards. Contextualization guides teachers in linking concepts and instruction to learners' prior knowledge or experience from home or community. This is the easiest way to connect or bridge what teachers need

[12] Here and throughout this chapter the teachers' role has been identified by the abbreviation "R" (Role), the simulation number, role number and lowercase letter.

in school to real life events. Connections between the formal concepts of diversity and everyday events makes the new information more relevant and meaningful, provides authentic contexts for applying personal knowledge to teachers' job. The primary aim of LLD standard is to provide activities that are rich in language use and students' jargon. Language is best learned through purposeful conversation in authentic contexts. Storyboards promote language development by creating tasks that generate teachers' understanding about how learners express themselves. Language is the fundamental tool used for students' cognitive development. At activity centers, teachers take a simulated role to engage in dialogue with peers and the expert, and use every day language in extended speaking, reading, and writing activities. An example of storyboard script and task card for ACU-2 is showed in Figure 25.

Presentation:

Today our experience looks at culture diversity between European and non-European cultures in the scope of Comenius programme and we start with one person from European country and Ecuadorian describing an experience he had when he first visited Spain.

Upstream activities

Each participant prepares various activities such as photo exhibits, presentations about the history, traditions and cultures of the country he/she represents and theatrical performance.

Responsibilities

- Experts encourage teacher interaction and mutual assistance.
- Experts praise teacher often for appropriate participation.
- Expert monitors teachers while they work.
- Teachers interact positively over tasks, providing mutual assistance.
- Teachers succeed in collaborative activities to generate shared products.
- Teachers perform tasks with high rates of success.
- Teachers work without expert assistance on tasks.
- Teachers use and maintain classroom systems for storing, retrieving, and circulating work products.

Script

(This script describes a moment when two cultures collided, a moment of 'culture shock'. People who spend time living in another culture have many moments like this. But 'culture shock' isn't simply a series of small incidents that upset or puzzle us. It's more a process - and, in fact, it's a process that many of us will have experienced without ever leaving home. The degree to which people experience culture shock when they visit a foreign country depends on several things. One of the most important of these is 'cultural distance' - how different is the culture that you're visiting from the one that you've grown up in.)

- R21a*: When I first went to Spain I was absolutely, absolutely shocked. There were three of us. Two of us Danish and there was one Spanish person. Right in the middle of the conversation he takes out a mobile and starts speaking, without even saying 'excuse me' or whatever.*
- R25b*: Hi, my "ñaño" (brother)! My "Viejo" (father) decided to come to Spain when I was young. When I first arrived I was only probably about 15 - what surprised me was the journey from the airport, it was drizzling, it was middle of October, I was in a "buseta" (bus), I was looking at the dark rooftops - it all seemed very, very strange. But soon enough I managed to find my gallada".*

  -Gallada is a gang, literally refers to group of young people out having fun and raising a ruckus-
- R27a: ...
- R29: ...

Figure 25. ACU-2 Task card example.

From Bloom's perspective IIC facilitates Knowledge, Comprehension and Application levels. Outcomes must be real places reproductions, role-play activities and structured learning objects as MOLs, RMOLs, or digital contents.

Conflict Resolution Center (CRC) is an IIC where teachers and experts focus on teaching content material using a conversational approach, engaging teachers in sustained dialogue. The focus of instructional activities shifts from review and content themes to more complex thinking activities such as analysis and diversity problem solving. Teachers increase their participation with activity center logistics, tasks, and community functions.

From pedagogical perspective CRC promotes JPA and CA standards. Challenging Activities include:

- High expectations for learners' performance on a challenging task.
- Assessment by peer, or self.
- Assistance through modeling, explaining, interacting, and feedback.

Bloom's Taxonomy is useful in designing Challenging Activities because it describes levels of cognitive function, from a lower level of learning rote knowledge; to comprehension, application, and analysis; and to the highest levels of synthesis and evaluation. In particular, we consider Application, Synthesis and Evaluation levels. CRC outcomes include in/out-world co-browsing panels, action plans, and SCORM learning objects for a subsequent review or training.

5.5.4 Procedure

Case studies took place from September 2011 to June 2012. Planning for a successful implementation of simulations and role-play activities helps us to take account of developments occurring during the development phase. After a comprehensive assessment of compiled documentation, participants, and instructional units' designs, 2 October 2011 was set as the go-live date for the preparatory exercises for both groups: RCGR and VWGR. The next table (Table 13) shows the planning of all activities.

Simulation	*Date*
ACU-1	November, 2011
ACU-2	January, 2012
ACU-3	March, 2012

Table 13. Simulations and role-play Planning.

The same instructional unit was carried out in both real environment and MMOL platform. Teachers were approached to voluntarily take part in one of the two research groups and they can play all roles freely. After a free choice, the assigned roles are showed in Table 12. During simulations and on-line role-play teachers received help from two experts in diversity field. After experiences all teachers and experts review results, material and strategies, allowing experts and teachers to ensure accurate assessment of learning outcomes, including knowledge, skills, attitudes and values. The main assessment tool used to assess learning outcomes is the Standards Performance Continuum

(SPC)[13] (Doherty, Hilberg, Epaloose, and Tharp, 2002; Hilberg, Doherty, Epaloose, and Tharp, 2004), to define use of each standard in a teaching improvement process and to highlight the importance of using multiple standards simultaneously in real/virtual activity centers. All teachers received a preparatory class about the use and assessment of SPC. The SPC defines distinct levels of implementation along a continuum to develop a measure that would provide quantitative data on the quality of teachers' implementation of the Five Standards. Levels of standards performance are: (a) *Not Observed*, the standard is not present; (b) *Emerging*, elements of the standard are implemented; (c) *Developing*, the standard is partially implemented; (d) *Enacting*, standard is fully implemented; and (e) *Integrating*, at least three standards are implemented simultaneously in a single instructional activity (all Enacting level ratings in the same activity then become Integrating). In addition to individual subscale scores (range 0 to 4) and the highest possible total score is 20, with overall levels of enactment defined as follows (Table 14):

Level	***Total Score***
Emerging	[0, 7.49]
Developing	[7.50, 12.49]
Enacting	[12.50, 17.49]
Integrating	[17.50, 20.00]

Table 14. Overall levels of enactment.

[13] SPC is available at http://gse.berkeley.edu/research/credearchive/standards/spac_chart.shtml

After each experience, each teacher values SPC items based on their experience, adopted role and group's members simulated behaviors reflect on the role-play activity, in particular teacher’s role. Total score, found by summing across subscales.

In both cases (i.e., RCGR and VWGR), the coaching process itself was retried three times (ACU-1, ACU-2 and ACU-3) and had three stages, which correspond to the three activity centers described above. For stage one, experts and teachers meet in IIC for 30 minutes to jointly plan one of three instructional units designed. For stage two, experts observe the jointly planned role-play activity for at least 60 minutes, gathering evidence for the follow-up discussion. SPC ratings, teacher and other roles talk, and notes on the nature of interactions are scripted throughout the observation at the activity center (MCC). For stage three, experts and teachers hold a 45-minute debriefing in CRC to identify strengths and weaknesses in the simulation and on-line role-play. The SPC is used regularly in the planning, observing, and debriefing stages of each coaching cycle to reinforce the performance targets for simulation.

5.6 Evaluation method

In order to obtain significant and meaningful results, the evaluation method proposed aims to yield a mixed evaluation combining SPC results, platform’s log events (VWGR) and direct observations with data analysis in a holistic interpretative approach. Figure 26 represents this evaluation method.

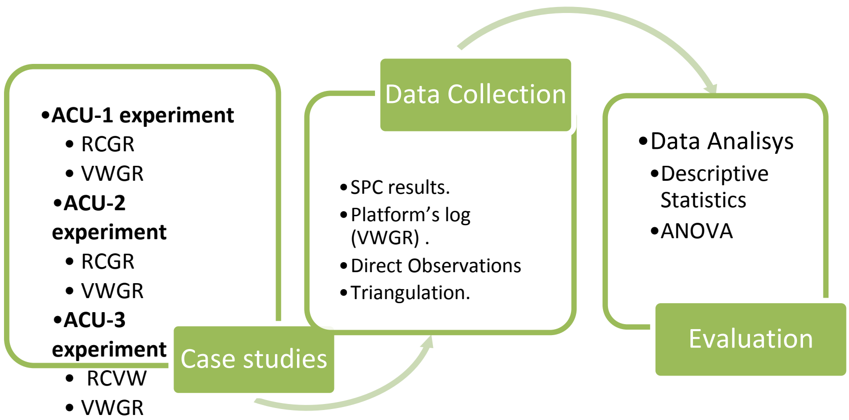

Figure 26. Evaluation method

Data analysis requires two steps to determine the nature and quality of teacher training improvement using the coaching process in both environments: real and virtual. The first step is to run descriptive statistics for all independent and dependent variables in order to obtain averages, frequencies, and standard deviations. Second step consist of conduct multiple repeat measures one-way Analysis of Variance (ANOVA) in both groups relating to: Joint productive activity (JPA), Language and Literacy Development (LLD), Contextualization (CXT), Challenging Activities (CA), Instructional Conversations (IC), and the overall Total Score for all Five Standards. The ANOVA is used to determine if and when changes across experiences and groups were significantly different. All the assumptions required to ANOVA strictly complied with. Mauchly's sphericity test (i.e., checks if variances between averages are equal, requiring statistical correction) was not significant for any dependent variables. Reported within-subject effects use the Lower-bound F-statistic at $p < .05$. A partial eta squared value was used to identify small (< 0.20), medium (>0.20 and < 0.79) and large ($> .080$) effect sizes. A graphical representation of the development for each group and the total score is showed in order to determinate underlying trends. Finally, tests of within-subjects contrasts and platform's log events (VWGR) indicate if a significant trend or pattern exists in the data.

5.7 Results

The findings address the nature and quality of change in teacher use of the Five Standards Instructional Model elicited through instructional process in a comparative study between real classrooms vs. MMOL platforms. Research question asks whether there is an increase in teacher use of the Five Standards as measured by individual standards (highest possible score= 4) and Total Score (highest possible score= 20) across the coaching process when teachers use MMOL platforms. Table 15 provides the mean, standard deviations, and number of subjects for each of the Five Standards and Total Score by simulations and groups. Means for each standard and Total Score consistently increase from one simulation to the next from simulation one, three and five (RCGR) on the one hand; and two, four and six on the other (VWGR), which means that teacher's teach improves as the coaching process progresses. Similarly, standard deviations (SDs) generally increased, with few exceptions, across simulations, showing increasing variation among teachers' perceptions about standards implementation. The SD for IC was the largest of all the Five Standards from all simulations; as the standard deviation rather depends on particular teachers' ideas about conversational approach to engage students in sustained dialogue. Similar results have been found by other researchers studying Five Standards to improving teacher pedagogy and classroom organization (Teemant, Tyra and Vogt, 2009; Teemant, Tyra and Wink, 2009).

			JPA	LLD	CTX	CA	IC	Total
ACU-1	***RCGR (Sim1)***	*Mean*	1.78	2.08	1.47	1.58	1.19	8,10
		SD	0.77	0.72	0.68	0.61	0.94	2.82
		n	10	10	10	10	10	10
	VWGR (Sim2)	*Mean*	2.43	2.50	2.77	2.06	2.48	12.24
		SD	0.92	1.00	1.07	0.72	1.06	3.87
		n	10	10	10	10	10	10
ACU-2	***RCGR (Sim3)***	*Mean*	2.26	2.45	2.09	2.14	2.01	10.95
		SD	1.08	0.95	0.73	1.02	1.13	4.01
		n	10	10	10	10	10	10
	VWGR (Sim4)	*Mean*	3.01	2.85	3.29	3.18	2.77	15.10
		SD	0.90	0.94	1.29	1.05	1.19	4.47
		n	10	10	10	10	10	10
ACU-3	***RCGR (Sim5)***	*Mean*	2.81	2.96	2.33	2.78	2.24	13.12
		SD	1.07	0.98	1.20	1.06	1.46	4.87
		n	10	10	10	10	10	10
	VWGR (Sim6)	*Mean*	3.37	3.39	3.74	3.35	3.68	***17.53***
		SD	1.04	0.99	1.17	1.06	1.45	4.81
		n	10	10	10	10	10	10

Table 15. Means, Standard Deviations and frec. for the Five Standards and Total Score by simulation and group.

Overall levels of Five Standard enactment show that MMOL platform allows results to be achieved more quickly. Taking into account Table 14 and total scores trends, VWGR reaches the Enacting Level during second simulation, while RCGR reaches it in the last simulation. Furthermore, sixth simulation on MMOL platform with a total score of 17.56, suggests that teachers design, enact, and collaborate in activities that demonstrate skillful integration of multiple standards simultaneously, such is the case of Integrating Level. RCGR is always below this threshold.

Table 16 presents Total Score means, standard errors, and 95% confidence intervals for each simulation.

Simulation	Mean	SE	95 % Confidence Interval*	
			Lower Limit	Upper Limit
Sim 1	8.10	0.55	7.57	8.63
Sim 2	12.24	0.90	11.51	12.97
Sim 3	10.95	0.74	10.19	11.71
Sim 4	15.10	0.95	14.26	15.94
Sim 5	13.12	0.81	12.20	14.04
Sim 6	17.53	1.02	16.62	18.44

Table 16. Total Score Mean, Standard Error and Confidence Interval. * $p <= 0.05$

A detailed study about with-in subject contrasts shows a significant and large effect for linear trend in teacher performance across simulations. In the case of MMOL platform simulations, this trend is even more pronounced (Sum of square = 1198.86, F = 76.62, Eta square= 0.81 and p < 0.001). Figure 27 plots the Total Score means as a line graph both RCGR and VWGR.

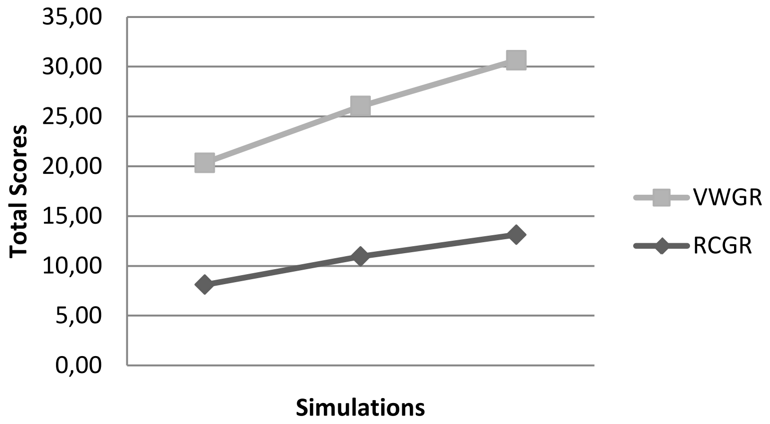

Figure 27. Linear trend of simulations.

Repeated measures ANOVA revealed there are significant differences in use of the Five Standards, measured by standards and total mean score, between RCGR and VWGR. The next table (Table 17) totalizes results obtained in both groups.

		JPA	LLD	CTX	CA	IC	Total
RCGR (Sim 1, 3 and 5)	*Mean (a)*	2.24	2.50	1.96	2.17	1.81	10.72
	n	10	10	10	10	10	10
VWGR (Sim 2, 4 and 6)	*Mean (b)*	2.94	2.91	3.27	2.86	2.98	14.96
	n	10	10	10	10	10	10
Mean increment (b –a)		+0.65	+0.42	**+1.30**	+0.70	+1.16	+4,23

Table 17. Totalized means by group and mean increment.

Taking into consideration the above table (Table 16), if there is something particularly remarkable is the significant differences between teacher's perceptions in use of each of the Five Standards individually when MMOL platform (VWGR) is used. F-statistic, F (1,9), confirms the preliminary findings: JPA = 34.61, LLD = 27.64, CTX = 67.49, CA = 34.58, IC = 58.79. The partial eta square values indicated large effect sizes for CTX (0.76) and IC (0.71) and medium effect for JPA (0.62), CA (0.61) and LLD (0.48). All results indicate that CXT measures are the largest of all standards when MMOL platform is used and present a continued growth throughout simulations.

Other important question is what trend or pattern of development emerged across RCGR and VWGR simulations of the Five Standards Instructional Model. Table 18 and Figure 28 present Total Score mean differences. Additionally, Table 18 shows standard errors and 95% confidence intervals for statistically significant simulation-to-simulation pairwise comparisons in teachers' valuation. In our case the most significant pairwise comparisons measure the impact of differences in applied MMOL platforms (RCGR vs. VWGR).

Simulations X	Simulations Y	Mean Diff. (X-Y)	SE	95 % Confidence Interval Lower Limit	95 % Confidence Interval Upper Limit
Sim 1	*Sim 2*	-4.14	1.31	-8.64	-3.17
	Sim 4	-7.00	0.84	-9.57	-6.05
	Sim 6	-9.43	1.00	-10.70	-6.54
Sim 3	*Sim 4*	-4.15	1.10	-7.87	-3.27
	Sim 6	-6.58	1.17	-8.82	-3.95
Sim 5	*Sim 6*	-4.41	1.34	-9.25	-3.38

Table 18. Mean Differences, Standard Errors and Confidence Intervals for Total Score pairwise comparisons. *(p<0.05)*

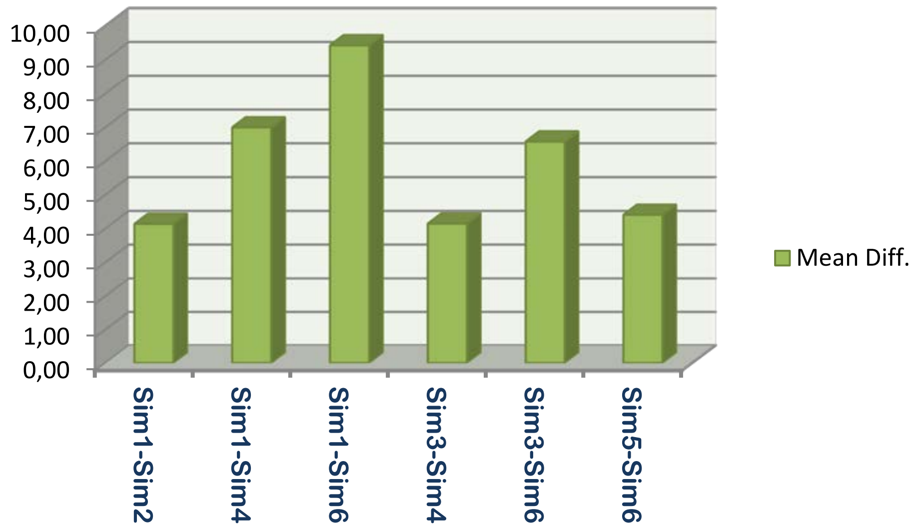

Figure 28. Mean Differences between groups' simulations *(absolute values)*.

All total score mean differences between simulation one and each subsequent VWRG simulations and between simulations tree and five, and each subsequent VWRG simulations are statistically significant.

The only other significant question in total score occurred in the continuous VWGR improvement across simulations, thereby the difference between simulation one and two is 4.14 and between simulation five and six is 4.41.

Figure 28 presents the mean change simulation to simulation as a bar graph. The greatest amount of change in teacher pedagogy, as measured by total score, occurs between simulation one and six, i.e. between the first RCGR and the last VWGR simulation. Together these findings demonstrate clear trends in teacher development and change.

5.8 Conclusions

Findings indicate that Five Standards role-play activities, where the SPC provides the standards against which teacher performance is measured, is an effective professional development strategy for working with teachers in public school settings with diversity problems. Simulations on MMOL platform lead to statistically significant increases in teacher use of the Five Standards measured individually and as total score. Simulation also leads to a statistically significant overall trend of greater use of the Five Standards over simulations that make use of MMOL platform, with peak performance occurring at simulations four and six.

One area that seems to be lacking is a theoretical perspective on knowledge creation inside of simulations. There is very little that deals specifically with the instructional design of simulations (Magee, 2006). With regard to this issue two theoretical implications emerge from the findings. First, the role-play activities indicate that the instructional training process itself is effective in assisting teachers in knowledge their pedagogy to meet the learning needs of diverse learners. Anyway statistical comparison between groups shows VWGR indicators improved and this trend in teacher recognition of SPC levels were reaffirmed over three role-play activities. In this respect, particular attention should be paid to the use of a concrete instructional framework as we propose in this study based on the one hand, Ford and Harris framework (Ford and Harris, 1999) and on the other, the theoretical background of Tharp (Tharp et al., 2000) and Effective Pedagogy. Each role-play activity resulted in a progressive grasp, with the most rapid, linear, and significant change in teacher pedagogy occurring during VWGR simulations. In the context of this study, the coach-expert dialogue begins with co-planning, moves to observable teaching and learning actions, and then ends with reflection upon teaching actions in light of defined goals. Such instructional process, unlike other professional development strategies, is able to take advantage of immersive virtual context where teacher could play a more active and open role. Teachers can review or improve their pedagogical practice, using the main lines of the training role-play activities, with discernment devoid of fear of failure or ridicule, or of the need for applause or confirmation by an outside authority or colleague. MMOL platforms could also offer the security of the anonymity for participants by way of their avatars. Anonymity can also alleviate the emotional stress of face to face role plays (Bell, 2001). The interaction through avatars can change face-to-face relationship between teachers and coaches. In other words, teachers in virtual worlds can equally communicate with other teachers or coaches regardless of their position, beliefs and personal background. When teachers adopt student's role, can also find their identity and experience social interaction through avatars (Gee, 2009). In a real context, with real persons, there is no doubt that the development of this kind of attitudes could require over a longer training time period and possibly, the achievements are not replicable. VWGR role-play activities as a contextual-, social- and action-oriented process could promote measureable and meaningful transformation in teacher pedagogy. It is for this reason that CTX standard reaches the highest score when MMOL platform is used.

Second, the role-play activities outcomes also demonstrate that it is useful to coach with defined goals for teacher performance in mind (Ogilvie and Douglas 2007; Lainema 2009). The SPC and MMOL platform, in particular, provides concrete targets against which both teacher performance and training outcomes can be evaluated. This pedagogical and technical context responds to the question teachers and experts often ask, "Where should I begin to promote teacher's skill with diversity students?" The Five Standards instructional model, as the content of the training process, coupled with MMOL platforms, results in goal directed and performance-based transformation. The findings provide quantitative evidence of which goals for teacher performance are incorporate into teaching practice earlier when simulated-based context is used. Teachers move more quickly to incorporate rich contextualization (CXT), instructional conversation (IC), collaborative products (JPA), better understanding of the language used by students (LLD) and clear expectations with higher cognitive challenge (CA).

5.9 Future work.

However, it is important to note the difficulties encountered in an appropriate role-play activities development, future work and related issues. According to Magee (Magee, 2006) the weaknesses of educational simulations are the need for a considerable amount of research. A lack of realistic models inside the simulation, unprofessional behavior by players, unrealistic levels of complexity in the environment and questionable transfer of skills from the virtual world to the real one could be an important drawback of this proposal. Many of the criticisms about simulations and educational games are common complaints for many poorly presented and poorly designed educational resources. It is not the concept of simulated-based learning that needs to be evaluated as much as their appropriate design and use. For this reason, future work in this area should focus on making high quality 3D objects repositories, and methodological and pedagogical guidelines to role-play activities implementation in other educational fields not included herein.

Other outstanding issue is that e-learning standards might not seem immediately relevant to a discussion about educational simulations. Standard-based learning 2D objects often come with a set of philosophical assumptions that will affect the kinds of design, development and deployment tools that are available to an instructional designer. Traditional e-learning standards are still relevant but it will be necessary to ensure that these standards do not restrict the ability of simulations to be developed to address current and future situations as well. It is therefore important to consider that other future work is the development of new 3D objects' standards, such as MOL (Minimum Object of 3D Learning) or RMOL (Reusable Minimum Object of 3D Learning).

Chapter 6. Case Three. Student skill improvement in foreign languages learning.

6.1 Introduction

Multi-user online environments have been used for immersive language learning in different contexts. Since the rise of Multi-user domains Object-Oriented (MOO), language teachers have used these environments to promote cultural exchange and learning of second languages (Shield, 2003). Active Worlds[14] emerged later as a virtual reality platform, and was use in the Virtual Wedding project for a constructivist learning of English as described by Svensson (2003). In parallel, Williams and Weetman (2003) describe the use of the Adobe Atmosphere[15] platform to promote language learning in the Babel-M project.

Currently, virtual worlds like Second Life[16] have drastically increased their role in language teaching, hosting large-scale projects,

[14] http://www.activeworlds.com
[15] http://www.adobe.com/products/atmosphere/
[16] http://secondlife.com/

such as Languagelab.com and Avatar Languages[17] (Kervin and Derewianka, 2011; Vickers, 2010). Virtual worlds are capable of changing the nature of learning by simultaneously providing a social, immersive and creative experience for language learners (Canfield, 2008; Cooke-Plagwitz, 2008; Chan, 2008; Jeffery and Collins, 2008). In addition, the improvements promoted by Second Life regarding the attitudes of language students, including their motivation and autonomy, have been assessed (Hislope, 2008; Peterson, 2011). Since 2009, the vice president of technology development for Linden Lab, Joe Miller, argued that language learning was the most common educational activity in Second Life.

In parallel to Second Life, a new genre of technologies for virtual worlds, including Open Wonderland[18], Open Croquet[19] and OpenSim[20], has evolved. They are characterized by the fact that the servers running the immersive environments are fully controlled and managed by the organizations that use them. The combination of these worlds would result in a 3D web (Kaplan and Yankelovich, 2011). These open technologies are also being applied to collaborative learning of second languages. The 3D multi-user environment developed in Open Wonderland by Ibanez et al. (2010) to encourage Spanish learning can be taken as an example. The European project `Networked Interaction in

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[17] http://www.avatarlanguages.com
[18] http://openwonderland.org/
[19] http://opencroquet.org/
[20] http://opensimulator.org/

Foreign Language Acquisition and Research (NIFLAR)´[21] has been implemented both in Second Life and OpenSim, specifically focusing on making the language learning process more interactive. The European project `Access to Virtual and Action Learning live ONline (AVALON)´ [22] follows similar objectives. Other relevant initiative is Xenos project[23] as an example of open-source language learning portal – an online universe where people can gather and practice using a second language in natural and authentic ways through immersive environment. Xenos includes a living community of learners from around the world who are able to interact with others through games and activities.

The present case study illustrates the key points of the SLRoute project, funded by the program `*Avanza Contenidos*´ of the Spanish Ministry of Industry. The project aims at developing a serious educational game on an immersive platform as a tool for foreigners to learn Spanish. SLRoute is conceived as an integration of Spanish language teaching with aspects of Spanish culture and history. In particular, a collaborative history can be followed during the game, contextualized in the form of scenarios within the different routes of the Way of St. James (`*Camino de Santiago*´).

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[21] http://niflar.ning.com/

[22] http://avalon-project.ning.com/

[23] http://www.learninggamesnetwork.org/projects/xenos/

6.2 MMOL platform for foreign language learning: Educational issues.

In voice and video-enabled 3D educational virtual worlds, students participate as avatars; can engage in textual, voiced and viewed interactions with other avatars and can undertake all kind of actions (fly, walk, sit down, run, dance, take and give objects, build 3D objects, etc.) they can be teleported to different places, villages, cities or public and private spaces (churches, shops, squares, restaurants, hospitals, hotels, cathedrals, hostels, theatres, museum), just by a simple mouse click. These different context and the possibilities of undertaking action while communicating with others, make 3D virtual worlds a potentially interesting environment for education in general, and foreign language teaching, in particular.

Several studies show that these 3D educational environments are a suitable space for language teaching (Bryant, 2006; Thorne, 2008; Deutschmann, Panichi and Molka-Danielsen, 2009; Warburton, 2009), for incentive task between students (Peterson, 2010; 2011) and a place where foreign language students can meet native speakers of the target language for engaging in meaningful communicative and social interaction while undertaking joint action in different environments (Kuriskak and Luke, 2009; Jauregi, Graaff, Bergh, Kriz and Gaag, 2012). Various scholars have studied the theories appropriate for virtual world-based learning, and the value of utilizing network-based learning in Computer Assisted Language Learning (CALL). Petraku (Petraku, 2010) shows that present research is largely exploratory in nature with significant limitations. This research highlights the urgent need for additional studies. The present experience tries to tackle the lack of theoretical and practical studies in CALL area. According with theories about Second Language Acquisition (SLA) role-play is essential to allowing successful language learning (Gass, 2000). From this perspective, MMOL platforms appear as promising arenas for language learning and incorporate elements that offer a number of potential benefits for students. Such is the case with network-based real-time text and voice chat, challenging theme and goal-based interaction, personal avatars or chat bots. The presence of native speakers like real persons or bots creates the conditions in which communication requirements may appear, providing opportunities for students to strengthen their communicational capabilities. In-world synchronous communication tools provide real-time feedback and the simulation of a real environment where the meaning of words and how to use them it is most significant. The cooperative and collaborative nature of student social interaction during in-world experiences may be conducive to increased communication skills involving dialog, co-construction in the new language, and the creation of a "Zone of Proximal Development" ZPD (Vygotsky, 1978), that are held from the perspective of sociocultural research, to facilitate language learning. In addition to cooperative and collaborative theories of SLA, the supportive atmosphere frequently engendered by interaction in educational virtual worlds can support the development of interpersonal relationships based on the exchange of personal information. All of which contributes to the social cohesion and sense of community that has been identified in studies on the use of virtual worlds in CALL (Peterson, 2009).

The opportunities for communication, immersion, situated learning, and social interaction in MMOL platforms made possible by well-designed and meaningful scenarios would appear to provide an adequate scenario for language learning. Furthermore, the high levels of interest and motivation reported in the literature are challenging to replicate in face to face language classrooms (Bryant, 2006). In order to establish whether the hypothesized benefits outlined previously are realized in learner-based studies, the following research will examine the MMOL platforms potential, as a referential example of CALL, in order to improve learners' skills in SLA

6.3 Resources and settings

6.3.1 OpenSim as an immersive environment for learning Spanish.

Some experts believe that kids' affinity for video games is no reason to give them more of the same at school. It all depends on how you use it. Students now want to play more of a role in their education. This technology is what they have grown up with, and how they think they learn better. The MMOL platforms do not lend themselves to every academic discipline, but foreign language learning could be one of the most suitable. For this reason, it is necessary to establish the convenience of using these technologies in a rich environment with synchronous capabilities.

SLRoute project sever has been implemented on a MMOL platform specifically created for this purpose (Lorenzo, 2010; Lorenzo et al., 2012). The generic representation of this architecture is shown in Figure 29.

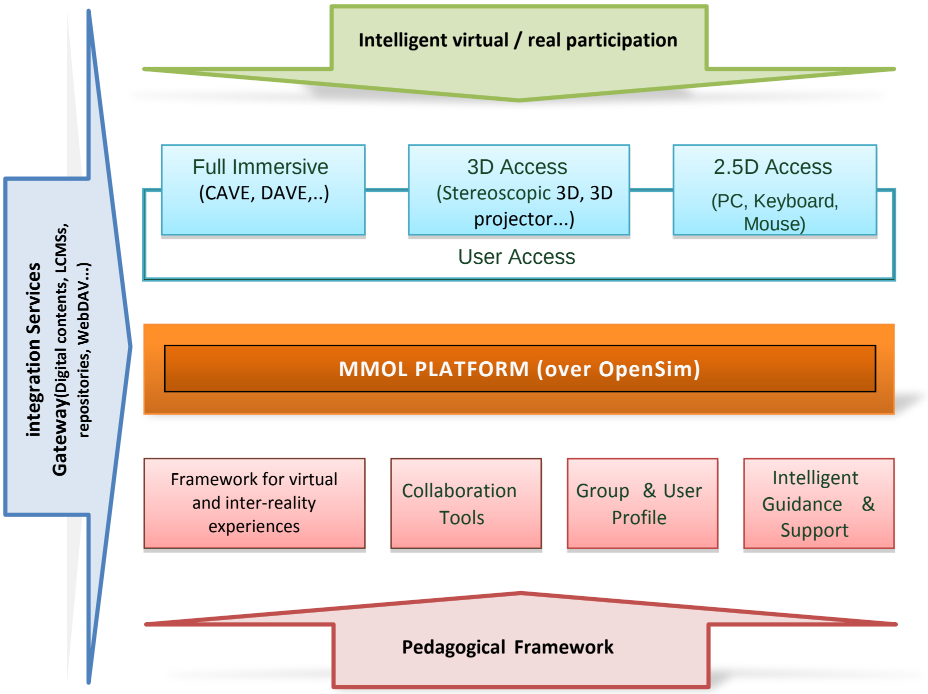

Figure 29. SLRoute server architecture

(Adapted from Lorenzo et al., 2012)

As reviewed in earlier chapters, MMOL platforms or educational virtual worlds are mixed reality environments constructed over virtual world servers that provide an interactive learning space by means of 2D, 2.5D or 3D technologies to build and manage collaborative and on-going online learning environments in which individuals participate using a real or a figurative presence (avatar) (Lorenzo et al., 2012). In our case the chosen virtual world is OpenSim which has been adapted to ensure fulfillment of the project's goals.

The use of OpenSim as an immersive environment for language learning is a very useful application.

About intelligent user's participation –real or virtual– 2.5D Graphical User Interface (GUI), also referred like "pseudo-3D" or "perspective ¾", is the most common form. Virtual world is reachable trough 2D graphical representation and techniques which cause a series of images or scenes to appear to be three-dimensional (3D) when in fact they are only two dimensions. Other GUIs, like full immersive or 3D, are only limited by the available client's resources –for example, if graphic card and displays will be able to support the interface and if the processor has sufficient speed–. In our study mostly students are equipped with up-to-date personal computers or laptops with capacity such as to allow adequate surfing on SLRoute servers browsing contents with 2.5D GUI. The students could be participate in-world in a figurative manner by their customizable avatars, but also they could do it in a more realistic form, i.e., by their own voice and image. In this case, each student has a webcam and a chat headset or a microphone and speakers. User's webcam images could be projected on in-world panel that shows webcams of all participants to facilitate live-chatting and synchronous communications skills. The selected user client is a cutting edge viewer named "Teapot viewer"[24].

Another issue is the MMOL platform integration with other servers, back-end services, and workflows. In this initial phase we have developed only one island that represents some stages of the Way of St. James, all of them near Alcalá de Henares as one of the various starting points of this road. Each stage depicts different rural villages, towns and historical buildings imported in-world like meshes. To make the import must be used an integration content tool, such is the case with assistants to transform 3D models to native OpenSim

[24] http://code.google.com/p/teapot-viewer/

meshes. Due to the complexity of the design of realistic scenarios to simulate the Way of St. James, meshes for exchanging digital assets, in particular COLLADA[25] (Collaborative Design Activity), are generated by means of the Blender[26] modeling program. For a proper rendering on the client side, the COLLADA format has been exported to a rendering engine named Ogre3D[27].

Other examples of service integration are:

- Authentication service, based on OpenID authentication. This will enable us in future to adopt Single Sign-On (SSO) mechanism.
- Repository service, by integrating selected resources like sounds, textures, images, notecards, scripts, avatar components, etc. stored in distributed assets servers, which will enable us to develop the concept of Minimum Object of 3D Learning (MOL) and Reusable MOL (RMOL).
- Out-world digital contents integration, like YouTube videos or Learning Content Management System (LCMS) resources and services.
- Intelligent agent hosted in specialized server.

Much of these functionalities are possible because the server's underlying architecture is designed as a grid environment. This lets us add easily islands, stages, resources and services to improve the MMOL platform capabilities and the global representation of the Way of St. James. Furthermore, this will provide greater transparency on the integration with other regions and virtual worlds created for the same purpose.

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[25] http://www.Collada.org/
[26] http://www.blender.org
[27] http://www.ogre3d.org/

About the educational and pedagogical issues the MMOL platform must provide an on-going learning and dialogue context to enable it to maximize the results of this collaborative environment and achieve project objectives. It is therefore important that MMOL platform, used as foreign languages learning tool, includes features such as:

- Framework for virtual and inter-reality experiences. The core issue is the virtual world server. As mentioned above SLRoute project has initially chosen an OpenSim server (Rel 0.7.3) for the creation of an island in which 3D content can be imported in various formats. But storyboard tools and development training instruments and learning materials are necessary for a correct description of challenges and activities which encourage more learner-centered and participatory learning into the educational virtual world. In our study the storyboards and learning materials were written for specialist who knows the ins and outs of virtual reality. Part of these dialogues was embedded as in-world bot's conversation with students. The succeeding phases and developments should facilitate the integration of these tools and instruments into the MMOL platform. Examples of story board and learning materials used in the initial stages are the next (Tables 19 and 20):

Activity Plan

Stage 1: From Train station to Alcala City			
General topics	**Grammar**	**Glossary of words**	**Phonetic**
Standard polite forms: - How to apply. - Name, age and date of birth. - Your home or office. - Greeting and closure. - Sorry and thanks.	*a)* Presente de indicativo de: *estar, llamarse, ser, haber.* *b) Tú / usted* c) Adjetivos de nacionalidad: género y número	▪ Numbers and alphabet ▪ Days of weeks, months and hours.	Numbers and alphabet pronunciation
The guests' hobbies and interests, places, hotel rooms, seasons...	a) Presente de indicativo de: tener, hablar b) Presente de indicativo de querer y gustar + inf. c) Adverbios bien, regular y mal d) Interrogativos: ¿cómo?, ¿qué?, ¿por qué?	▪ Sports ▪ Countries ▪ Subjects	"Letras trabadas"
- Ask people when you don't understand. - Thanks. - How to spell.	a) Interrogativos qué y cómo b) Presente de los verbos tener, decir, hablar, llamarse, escribir, leer, significar y saber c) Interrogativos dónde, cuándo, cuántos, qué + sustantivo	▪ Affirmative and negative adverbs. ▪ Apologise expressions.	"Consonantes finales de sílaba"

Table 19. Teacher's Activity Plan

Stage 1 Storyboard: From train station to Alcala Downtown.	
Context: The action begins in a train station.	
Resources: some money, book and newspaper.	
Action: The teacher is waiting for the student and takes him/her to the Alcala University	
Dialogue:	
Teacher	***Student***
Hola ¿Cómo te llamas? ***Yo me llamo Juan. ¿De dónde eres?*** ***De España ¿Y tú?*** ***Yo soy profesor de español (en su idioma). Veo que estás aprendiendo esta bella lengua que es el castellano.*** ***Si no entiendes algo, se pregunta así: ¿Cómo se dice……….. en español?*** ***Si no has entendido bien algo, debes decir: Más despacio ¿Puedes repetir por favor? No entiendo ¿Cómo se escribe? ¿Puedes deletrear? Vamos a practicarlo.***	*Me llamo ___ ¿Y tú?* *Yo soy de _____ ¿Y tú?* *Yo soy de ______ ¿A qué te dedicas?*

Table 20. Stage 1 Storyboard

- Collaboration tools. As explained below the SLRoute server includes synchronous communication tools like text chat, voice and video chat, co-browsing displays, bots, etc. Additional traditional asynchronous tools can be integrated in-world; such is the case of notecards, blackboards and forums, email, etc.
- Group and user profile. Learning materials and activities need to be tailored with regard to the students' diversity and initial knowledge level. SLRoute project is designed to allow you to choose your level of difficulty as you go. This way, the progress will depend on your initial Spanish level.
- Intelligent guide. As explained in next section Non Player Characters (NPC) or bots are the most important aspect in guiding users. These agents feature Artificial Intelligent to guide students toward their individual learning experience. For example to show a Pandora bot we can use the next LSL script (Figure 30):

```
key talker;
key requestid;
string botid;
string cust;
string bodyx;
string reply;
string newreply;
integer that_begin;
integer that_end;
integer cust_begin;
integer chat = 0;

// ******************************
string SearchAndReplace(string input, string old, string new)
{
  return llDumpList2String(llParseString2List(input, [old], []), new);
}
default
{
// ******************************
state_entry()
   {
      cust="";
      botid="f0934c636e3ddddd”; //This is Bot_Teacher  One
   }
// ******************************
on_rez(integer param)
   {
      llResetScript();
   }
    link_message(integer sender_num, integer num, string msg, key id)
   {
      requestid = llHTTPRequest(“http://www.pandorabots.com/pandora/talk-
xml?botid=”+botid+”&input=”+llEscapeURL(msg)+”&custid=”+cust,[HTTP_METHO
D,”POST”],””);
   }
   http_response(key request_id, integer status, list metadata, string body)
   {
      integer i;
      if (request_id == 179equested)
      {
         cust_begin=llSubStringIndex(body, “custid=”);
         cust=llGetSubString(body, cust_begin+8, cust_begin+23);
         that_begin = llSubStringIndex(body, “<that>”);
         that_end = llSubStringIndex(body, “</that>”);
         reply = llGetSubString(body, that_begin + 6, that_end – 1);
         newreply = SearchAndReplace(reply, “%20”, “ “);
```

```
            reply = newreply;
            newreply = SearchAndReplace(reply,”&quot;”,”\””);
            reply = newreply;
            newreply = SearchAndReplace(reply,”&lt;br&gt;”,”\n”);
            reply = newreply;
            newreply = SearchAndReplace(reply, “&gt;”, “>”);
            reply = newreply;
            newreply = SearchAndReplace(reply, “&lt;”, “<”);

            llSay(0, newreply);  //this line tells the bot to say it.
        }
    }
}
```

Figure 30. LSL script for Pandora bot integration.

MMOL platforms provide educators and students with the ability to connect and integrate all technologies and pedagogical principles in a way may potentially enhance the learning experience. Thus, the teacher could make use of a rich context to interact and collaborate with the students in a synchronous mode. The synchronous capabilities of MMOL platforms allow for a redefinition of the traditional teacher's role. As discussed in previous chapter, these platforms help to implement spaces to provide exploratory learning, role-playing, simulations and diverse types of scaffolding to accommodate individual cognitive differences, cases in point being Situated Learning and Problem-Based Learning based on the educational theories of Vygotsky (1978). Therefore, the pedagogical framework of this new virtual context is based on the broad principles through which these theories are applied specifically to teaching practice. (Lorenzo et al., 2012)

6.3.2 Using OpenSim for dialogue and synchronous capabilities

As detailed in the previous section, several projects have utilized OpenSim for foreign languages training, increasing the degree of it maturity in this domain. Undoubtedly, the key feature provided by the immersive environment for language learning is that of potentiating intra-world communication. The following tools are available for such goal:

a) Textual Chat: Allows participants to practice and correct their understanding of written Spanish, both from the point of view of expression, and the understanding of the message. The text exchanged between chat users is stored in viewer so it can be later retrieved for further review.

b) Voice and video chat: Allows the development of speaking skills. As in the previous case, there is the possibility of storing conversations for later review. Solutions based on FreeSwitch and Mumble can be herein used.

c) Chatbots or NPCs (Non Player Characters): They are automated avatars that guide the student in language learning process. New tools introduced by OpenSim support the *chatbot* programming, essentially by adding specific functions for the management and control of NPCs to the OSSL scripting language. (See Figure 31)

Figure 31. Avatar to chatbot interaction

d) Utilities to provide chatbots with artificial intelligence: In order for the chatbot to be able to maintain a conversation as close as possible to a human-like communication, the Artificial Intelligence Mark-up Language (AIML)[28] language has been used in combination with chatbots hosted in the `*Pandorabots*´[29] open source community.

e) Voice synthesis: To provide students with the proper diction of the practiced sentences.

In addition, the possibility of integrating new technologies in the virtual world to improve features of the teaching/learning process that are typical of language teaching will be explored. This may include: *Speech To Text Voice*, online translation systems and/or spelling correction systems.

6.4 Method

6.4.1 Research Model

This papers aims at assessing user acceptance of MMOL platforms by applying the Technology Acceptance Model (TAM) (Davis, 1989) and extended factors found in follow-up studies. TAM has been regarded as one of the most powerful models in examining the acceptance of new technology uses and adaptations. The effective use of TAM can provide practical findings, such as a better understanding of educational background associated with intentions to use, as well as anticipate interventions that may increase these intentions. In order to develop a research framework adapted to MMOL platforms, existing TAM studies on collaboration, cooperation, and communication technologies, systems, and applications such as on-line meeting systems, e-mail, educational games or web-based collaboration systems have been taken into account to

[28] http://www.alicebot.org/aiml.html
[29] http://www.pandorabots.com

build the research model in this study. According to scientific literature, the most common construct variables for technology adoption and acceptance are: (a) Perceived Ease of Use (PEOU), (b) Perceived Usefulness (PU), (c) Attitude towards Technology (ATT), (d) Behavioral Intention to Use (BTU), (e) Technology Playfulness (TP), (g) Computer Anxiety (CA), and (f) Socio-Demographical variables such as Gender or Age. A 5-point Likert scale (strongly disagree to strongly agree) has been used as a measurement scale for each construct variable. The proposed model in this contribution is based on insights from former related studies about user acceptance of technologies and applications for communication, cooperation, and collaboration (Gefen and Straub, 1997, 2000; Fang, Chan, Brzezinski and Xu, 2006; Fetscherin and Lattemann, 2008). The main survey items are showed in Table 21:

Construct Variable	Item ID	Question
Perceived Ease of Use (PEOU)	PEOU1	I found educational virtual worlds for learning languages easy to use
	PEOU2	Learning to use educational virtual worlds for learning languages would be easy for me.
	PEOU3	My interaction with educational virtual world for learning languages was clear and understandable.
	PEOU4	It would be easy for me to find information at educational virtual world for learning languages.
Perceived Usefulness (PU)	PU1	Using educational virtual world for learning languages would enhance my effectiveness in learning.
	PU2	Using educational virtual world for learning languages would improve my learning performance.
	PU3	Using educational virtual world for languages would increase productivity in my course work.
	PU4	Using educational virtual world for learning languages made easier for me to improve

		collaboration
	PU5	Using educational virtual world for languages made easier for me to communicate with classmate
	PU6	Overall, I find educational virtual worlds for learning languages useful in my study.
Attitude Towards using Technology (ATU)	ATU1	I like the idea of using educational virtual worlds for learning languages.
	ATU2	I have a generally favorable attitude toward using educational virtual worlds for learning languages.
	ATU3	I believe it is (would be) a good idea to use this educational virtual worlds for my course work.
	ATU4	Using educational virtual worlds for learning languages is funny.
Behavioral Intention to Use (BTU)	BTU1	I'll intend to use educational virtual worlds for learning languages during the semester.
	BTU2	I'll return to educational virtual worlds for learning languages often.
	BTU3	I'll intent to obtain information about educational virtual worlds for learning languages frequently for my course work
Technology Playfulness (TP)	TP1	Do you feel good using educational virtual worlds and educational games?
	TP2	Do you feel creative using educational virtual worlds and educational games?
	TP3	Do you feel imaginative using educational virtual worlds and educational games?
Computer Anxiety (CA)	CA1	Educational virtual worlds make me hesitate
	CA2	Educational virtual worlds don not scare me at all.

Table 21. Questionnaire items

Taking into account TAM foundations, both PU and PEOU are significant antecedent to explain BIU. As we explain above, PEOU concerns PU significantly, in particular hypothesis three (see Figure 32).

6.4.2 Hypothesis

Hypothesis 1 (H1). The perceived usefulness (PU) of MMOL platforms influences positively and directly behavioral intention to use (BIU) the system for language learning purposes.

Hypothesis 2 (H2). The perceived ease of use (PEOU) of MMOL platforms influences positively and directly the behavioral intention to use (BIU) the system for language learning purposes.

Hypothesis 3 (H3). The perceived ease of use (PEOU) of MMOL platforms influences positively and directly the usefulness (PU) of the system for language learning purposes.

According to Fetscherin and Lattemann (2008) the perceived usefulness plays a significant role to explain user acceptance and behavior in virtual worlds, because - compared with other technologies it can be expected that innovative features in virtual worlds, such as 3D animations and synchronous communication capabilities are of pivotal relevance to understand the diffusion and adoption of Virtual Worlds in a variety of applications, including educational virtual worlds. Additionally, MMOL platforms offer the possibility to improve the communication potential, against Web 2.0 tools, by applying advanced artificial intelligence learning algorithms and enabling chatbots' conversations utilities, mixed reality environments and avatar's gestures, mimics or emotions.

Using a strategy developed from case studies of extended TAM, TP, ATU and CA are all significant antecedents to PEOU, as set out in H4, H5 and H6.

Hypothesis 4 (H4). The technology playfulness (TP) of MMOL platforms influences positively and directly perceived usefulness (PU) of the system for language learning purposes.

Hypothesis 5 (H5). The attitude towards using technology (ATU) influences positively and directly perceived usefulness (PU) of the system for language learning purposes.

Hypothesis 6 (H6). The computer anxiety (CA) influences negatively and directly the perceived usefulness.

In order to consider other influences in learners' technology appreciation (Venkatesh et al., 2003) our research model includes several moderating variables, like age, gender or usual software experience: word processing, spreadsheet, presentations, video games, mobile apps, etc. as shown in the following table (Table 22).

Moderating Variables	
MV1	Age
MV2	Gender
MV3	Educational level
MV4	Please rate how often you use word processing program such as Word: Never, Occasionally, Often, Very often
MV5	Please rate how often you use presentation program such as Power Point
MV6	Please rate how often you use spreadsheet program such as Excel.
MV7	Please rate how often you use e-mail.
MV8	Please rate how often you use Internet.
MV9	Please rate how often you use video games.
MV10	Please rate how often you use mobile Apps.
MV11	Do you have an account and use Google +?
MV12	Do you have an account and use Facebook?
MV13	Do you have an account and use Twitter?
MV14	Do you have an account and use Second Life?

Table 22. Moderating variables.

Therefore, we define a new hypothesis associated with moderating variables:

Hypothesis 7 (H7). Socio-Demographical and experience variables moderate the perceived usefulness of MMOL platforms.

Based on TAM and extended TAM theories, the research model examines seven constructs: PEOU, PU, ATU, BTU, TP, CA and MV to use MMOL platforms for education purposes. The relationships among the variables and the hypotheses are depicted in Figure 32.

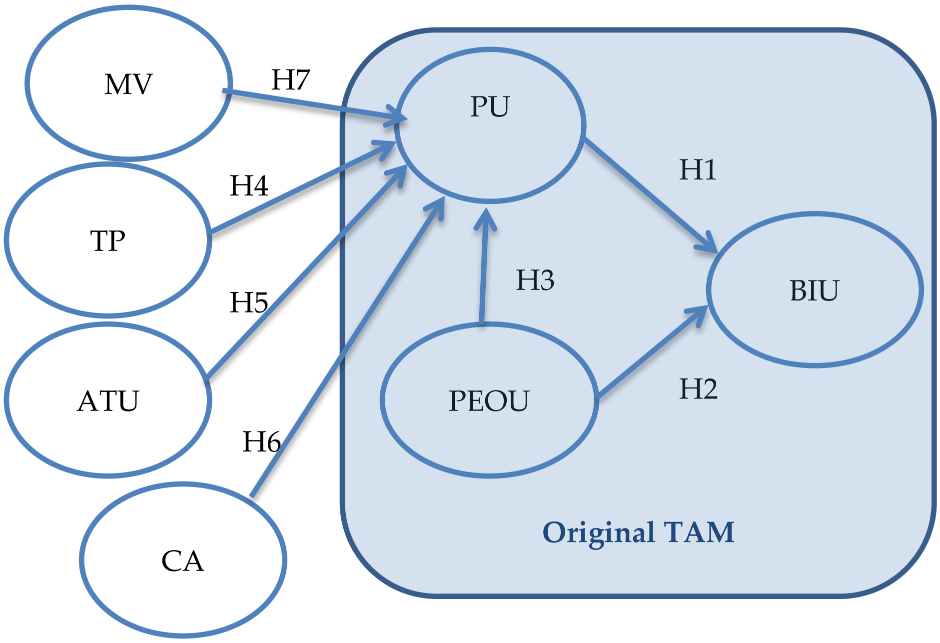

Figure 32. Research Model

6.4.2 Data Collection

Pre-tests were carried out in order to ensure the survey's reliability and to modify any questions that may create confusion or error. Because of the explorative character of the survey, the study bases on a convenience sample as it could not be expected to receive a totally random sample of MMOL platforms users. The data for this study is unique because behavioral data is collected at the individual level and consist of a sample of 35 respondents. The study was conducted during the second half of 2012 with undergraduate and continuing studies foreign students at University of Alcalá. Participants range in age from 20 to 37 seven years old. Prior to the survey, students were given a brief introduction to MMOL platform in general, and SLRoute in particular, and an assignment involving collaborative communication tasks. The proposed activities involved downloading and installing the client software, building prims and meshes, enabling voice, chat and video tools, conversing with chatbots, etc. After these basic activities, learners were asked to work in groups to complete tasks such as learning about how to ask question in Spanish, basic vocabulary, number and ordinals, etc. (as shown in Tables 19 and 20). This learning was accomplished with in-world real tutor explanations. After that students were invited to enhance their insights through complementary in-world non-guided sessions with the help of chabots or other co-participants. Following the assignment, students were given the URL to participate in the online survey and checking whether every participant filled out the survey only once time.

6.5 Data Analysis

6.5.1 Demographic Statistics

Among a total of 35 participants, 21 valid responses were collected. Among of the respondents, 58.3% were male and 41.7% were female. The respondents reported very often users in using word processing program (95.24%, n=20), spreadsheets (76.19%, n=16), presentations (85.71, n=18), e-mail (90.48, n=19%), Internet surfing (100%, n=21); often users in using video games (66.67%, n=14) and occasionally users in mobile Apps (61.90%, n=13). When participants were asked about whether they have an account and use a social networking the most used network was Facebook (80.95%, n=17), followed by Twitter (66.67%, n=14) and finally, Google+ (47.62, n=10). Participants were also asked about their use of Second Life. A majority had never used Second Life before (66.61%, n=14). Only a small number of responders had a Second Life account or used it regularly (28.57%, n=6).

6.5.2 Measurement Scale Validation

The data analysis was analyzed through path modeling, using the Partial Least Squares (PLS) method and was conducted using SmartPLS 2.0 (Ringle, Wende and Will, 2005). In practice, a PLS model is developed in two steps. In the first step, the model is founded by performing reliability on each of the measures to ensure that reliable and valid measures of the constructs variables are being employed. In the second step, the structural model is validated by estimating the paths between the constructs, determining their significance as well as the predictive capacity of the model.

In order to validate the proposed research model, the validity and reliability of this model and construct variables included, a test on Conbrach's Alpha was conducted for each construct variable and associated questions. Our study considers a Cronbach's Alpha of 0.60 for the lower bound. The Conbrach's Alpha value ranged from 0.87 to 0.66. As the reliability coefficients are all within commonly accepted values in the scientific literature (Nunnally, 1987; DeVellis, 2011) and according to Hair, Anderson, Tatham and Black (2009) the results suggest a high level of reliability of the proposed research model.

6.5.3 Structural Model Validation

The results confirmed the research model and the questions adapted from previous research. The validity of the construct variables was assessed using a factor analysis. The principal components method was used to obtain the main factors needed to check this research model. A factor loading greater than 0.60 with the theoretically correct sign was needed to the assignment of a question to a factor (DeVellis, 2011). The varimax criterion for analytic rotation was used to facilitate the interpretation of the extracted factors.

The number of factors is determined by using Kaiser's rule. This rule establishes that Eigenvalues greater than or equal to 1 should be considered as significant (Hair et al, 2009). Our analysis suggests a total of 10 factors to take into account for our further analysis. Additionally the factor loading was calculated. The following table (Table 23) shows the component matrix including the factor loading as the result of the factor analysis. The factor loading represents the correlation coefficients between the construct variables and factors. The coefficient of correlation indicates the degree of linear relationship between variables and factors, and is indicated by a value between -1 and 1. A positive correlation means that if one variable gets bigger, the other variable tends to get bigger. This dependency is stronger when coefficient is closer to one. A negative correlation means that if one variable gets bigger, the other variable tends to get smaller. Using a cutoff of 0.60 for factor loadings is possible to ensure a good correlation (Manly, 1994). The proposed research model shows a good construct fit as most cases each construct variable corresponds to a factor.

An Exploratory Factor Analysis (EFA) was performed with the objective to assess the basic structure of our proposed research model.

	Factors									
Variables	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**
PEOU1	0.07	0.02	-0.08	-0.02	0.88	0.01	0.03	-0.04	0.07	0.03
PEOU2	0.04	0.09	-0.18	0.05	0.85	0.00	0.00	0.07	0.00	-0.08
PEOU3	0.21	0.18	-0.32	0.14	0.57	0.07	0.23	0.03	-0.12	0.08
PEOU4	0.04	0.03	-0.05	0.14	0.73	0.15	0.01	-0.03	-0.02	0.06
PU1	0.07	0.04	0.06	0.88	0.04	0.03	0.01	0.00	0.00	0.02
PU2	0.24	0.28	0.01	0.68	0.12	0.00	-0.02	0.10	0.05	-0.07
PU3	0.11	0.35	0.09	0.65	.04	0.03	-0.01	0.11	0.02	-0.01
PU4	0.21	0.87	-0.02	0.16	0.09	0.13	0.09	0.04	0.04	-0.01
PU5	0.21	0.75	-0.01	0.14	0.09	0.16	0.07	0.10	-0.02	0.01
PU6	0.02	0.23	-0.03	0.78	0.06	.015	0.08	-0.04	0.00	0.00
ATU1	0.68	0.24	-0.04	0.17	0.19	0.06	-0.01	0.05	0.34	-0.01
ATU2	0.83	0.21	-0.17	0.05	0.11	0.11	0.00	0.07	0.06	-0.09
ATU3	0.84	0.19	-0.16	0.07	0.05	0.11	0.07	0.04	0.06	-0.07
ATU4	0.64	0.14	-0.20	0.06	0.22	0.24	0.09	0.25	0.18	-0.12
BTU1	0.30	0.06	-0.16	0.04	-0.01	0.64	-0.02	0.09	0.08	0.09
BTU2	0.29	0.25	0.00	-0.05	0.05	0.68	-0.06	0.02	0.06	0.00
BTU3	0.17	0.16	-0.08	-0.04	0.24	0.65	0.01	0.12	-0.15	-0.16
TP1	0.65	-0.05	0.03	0.11	-0.10	0.14	0.11	0.14	-0.13	0.00
TP2	0.73	0.03	-0.05	0.14	0.04	0.15	0.01	-0.03	-0.02	-0.06
TP3	0.75	0.21	-0.01	0.14	0.09	0.16	0.07	0.10	-0.02	-0.01
CA1	-0.12	0.03	0.81	0.10	-0.03	-0.04	-0.12	0.14	-0.01	-0.02
CA2	-0.10	0.00	0.78	0.11	-0.04	-0.06	0.08	-0.11	0.00	-0.07
MV1	0.27	-0.08	-0.23	0.08	-0.10	0.11	-0.04	-0.02	0.63	-0.16
MV2	0.11	-0.02	-0.03	0.00	-0.03	-0.05	-0.11	-0.04	-0.21	0.76
MV3	0.11	-0.03	-0.09	-0.01	-0.01	-0.01	0.11	-0.05	0.80	0.07
MV4	-0.04	-0.11	0.09	0.04	0.05	-0.10	0.05	0.75	-0.06	-0.25
MV5	-0.10	-0.12	0.21	0.05	-0.01	-0.10	0.23	0.79	-0.05	-0.14
MV6	-0.12	-0.03	0.11	0.10	-0.03	-0.07	-0.18	0.69	-0.01	-0.02
MV7	-0.07	0.26	-0.18	0.04	0.04	0.12	0.01	0.65	-0.05	-0.16
MV8	0.01	0.09	-0.16	0.07	0.05	0.11	0.07	0.74	-0.01	-0.07
MV9	-0.03	0.09	-0.18	0.05	0.05	0.00	0.00	0.67	0.02	-0.08
MV10	0.04	-0.02	-0.06	-0.02	-0.04	0.01	0.03	0.78	0.07	-0.03
MV11	0.21	0.28	0.01	0.10	0.12	0.00	-0.02	0.68	0.05	-0.07
MV12	0.19	0.16	-0.08	-0.04	-0.04	0.12	0.01	0.75	-0.15	-0.06
MV13	0.14	-0.05	0.03	0.11	-0.10	0.14	0.11	0.65	-0.13	-0.03
MV14	0.25	0.14	-0.20	0.06	0.22	0.24	0.09	0.44	0.18	-0.12

Table 23. Component Matrix.

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

PEOU is closely related with factor five in which three of the four items have a significant factor loading over 0.60. However, one item (PEOU3) has a factor loading of only 0.57, which means that it will be dropped as a measurement item. PU is strongly related with factors two and four. Factor two includes questions related to the perceived learner's communication (PU5) and collaboration (PU4) improvement when MMOL platforms are used. As many studies have emphasized, collaboration and communications capabilities of educational virtual world play a remarkable role in the adoption of this technology. Results suggest creating a new construct variable (Communication and Collaboration Capabilities, CCC) in order to group together those items, which requires an additional hypothesis:

Hypothesis 8 (H8). The perceived communication capabilities of MMOL platforms influence positively and directly the behavioral intention to use (BIU) the system for language learning purposes.

The other four items of perceived usefulness - PU1, PU2,PU3 and PU6 - had a significant factor loading of 0.88, 0.68, 0.65 and 0.78, respectively. The variable behavioral intention to use (BTU) is strongly associated with factor six; all items have a factor loading of 0.60 or higher. The constructs technology playfulness (TP) and attitude towards using technology (ATU) are both strongly related with factor one. These findings suggest that these variables should be merged into one single construct variable. As both deal with the attitude or playfulness, when MMOL platforms are used, we kept the name of the construct variable ATU. The construct variable computer anxiety (CA) is strongly related with factor three; the two measurement items- CA1 and CA2- are significant with values of 0.81 and 0.78, respectively. Finally, moderating variables are associated with factors eight, nine and ten. Educational level and age are loaded to the same factor (F9). Factor eight includes the item related to gender (MV2) with a remarkable correlation value. All items associated with computer and Internet experience (word processing programs, presentations, spreadsheets, e-mail, Internet, video games, mobile Apps, Google +, Facebook, Twitter) have a strong relation with factor ten. Only item associate with Second Life experience (MV14) has a factor loading of only 0.44, which means that it will be dropped as a measurement item. But as we would expect, this item is not significant because only a small number of responders had a Second Life account or used it regularly.

These findings are consistent with the results from other scholars (Venkatesh et al., 2003; Fetscherin and Lattemann, 2008).

This factor analysis shows some serious adaptations of the initial research method. In order to validate the various hypotheses we conducted a Confirmatory Factor Analysis (CFA) through a structural equation modeling. Multivariable test results of the structural model are depicted in Figure 30 which includes the regression coefficient for each factor as well as the significant level expressed as significant path.

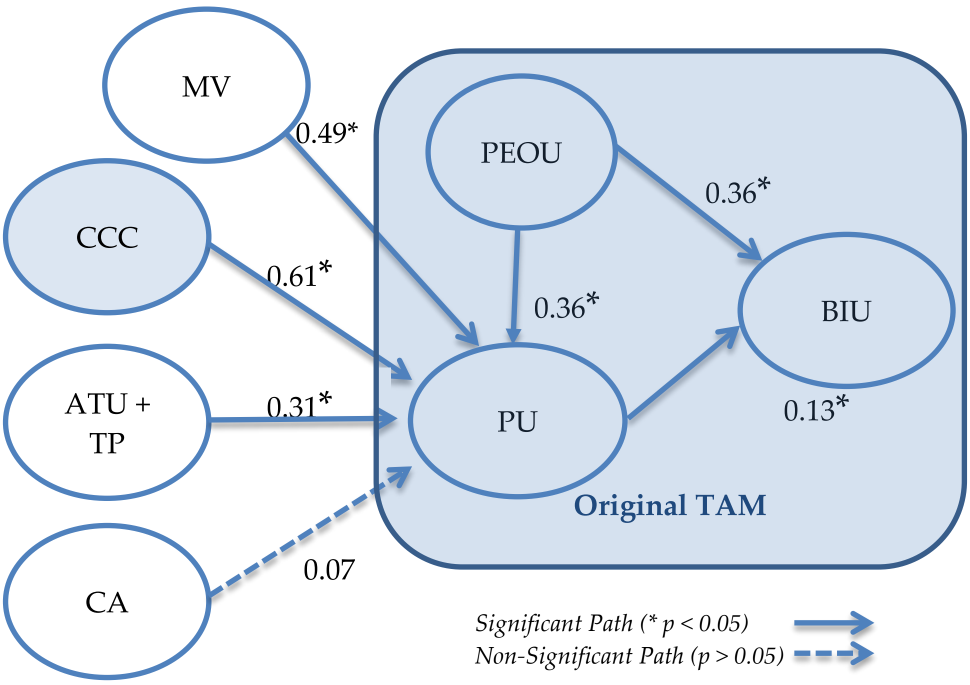

Figure 33. Redefined research model

Our findings support all hypotheses except Computer Anxiety (CA) which is positive but not significant. Each of the hypotheses include in Figure 32 are represented in Figure 33 by arrows. These hypotheses were tested automatically by calculating the standardized beta coefficient. Findings show that the most important features are communication and collaboration capabilities for the user adoption and acceptance of MMOL platforms. It has the highest value and therefore strongly influences the perceived usefulness of MMOL platform for language learning purposes. Furthermore, it should be clear that moderating variables (MV) are important too in most cases, as other authors point out (Gefen and Straub, 2000; 2003; Venkatesh et al., 2007).

According to Fetscherin and Lattemann (2008), we carried out other model validation by calculating the Root Mean Square Error of Approximation (RMSEA) in order to compare the variance-covariance matrix with the empirical variance-covariance matrix. The difference between the two matrixes must be range from 0 to 1. It is commonly accepted a value of 0.08; in our case we get a value of 0.077 which suggest that the proposed model reflects reality and mainstreaming of outcomes and results.

6.6 Conclusions

This study tries to examine factor associated with learner's intention to accept and use MMOL platforms for language learning based on Technology Acceptance Model (TAM). As previously stated, our proposal is broadly in line with previous research. However, this is one of the first attempts to identify the key factors which influence student's awareness about the use of educational virtual worlds for a specific purpose, as in the case of Spanish language learning. By means of in-world experiences and survey data with a significant sample from undergraduate and continuing studies foreign students the research model and underlying hypothesis were tested. The findings suggest that the model is statistically significant and well-constructed.

Results show that the possibility of cooperate and collaborate in an explicit social context, such as 3D educational environment, in combination with enhanced communication tools (chat, video chat or VoIP) and intelligent assistants (chatbots) play a pivotal role in user acceptance of MMOL platforms. In this respect, the most important determination of MMOL platform adoption seems the perceived value of cooperation, collaboration, communication and in-world assistance on MMOL platform. The high value of regression coefficient associated with CCC variable mean that this constructor is a significant antecedent to perceived usefulness.

Other factors proposed by Technology Acceptance Model are also relevant to determine user acceptance, such as attitude towards using technology (ATU), and moderating variables (MV) related with socio-demographical and experience factors. Moreover, its performance has direct consequences for instructional designer and educational institutions because the analysis suggests that communications and assistant capabilities and hence, the community idea is of crucial important for development, design and assessment of MMOL platforms. These construct variables would be taken into account in further research on MMOL platforms adoption and diffusion. Additionally, our findings also indicate that playful factor, as part of ATU construct, is significantly related to acceptance and use. Taken together, teachers and instructional designer should take into account such elements as, (a) encourage social engagement in the MMOL platform, (b) maximize the immersive potential of MMOL platform, (c) maximize the potential of self- and bot-directed learning, and (d) encourage the fun approach of MMOL platform.

Therefore, our findings point that MMOL platforms have the potential to provide a rich, engaging, collaborative and enjoyable learning environment for foreign language learning.

6.7 Future work.

Besides the more or less traditional means of content consultation, such as print, audio-visual and interactive formats, the most important aspect of the SLRoute project is the implementation of a MMOL platform, simultaneously offered through online access to hundreds of users. This platform will become an educational system to combine learning with adventure, interaction, social relations and online groups. It will involve 3D virtualization of the Spanish territory, including scenes recreated in detail, persistence on all routes and access to cultural content in all disciplines (i.e., music, literature, history, architecture, art, etc.), enabling students' immersion into the Spanish language and culture. However, there are certain limitations as regards the graphical requirements, network speed and artificial intelligent technics applied to chatbots' dialogues. These difficulties may have discouraged students, and could have contributed to some negative perception of MMOL platform. Additionally, the sample size (n=35) while sufficient for the exploratory nature of this research, may have limited the generalization of the findings.

There are many areas for further researches. Additionally studies can be conducted to examine the impacts of the same factors over time or the impact of different languages. These future works can cover issues such as , will the impact of PE, PEOU, BIU and the antecedents change over time, and if so, how? The results may further provide insight on factors that contribute to intention to adopt this technology.

Chapter 7. *Integrated discussion and future work.*

7.1 Introduction.

According to Kirriemuir (2008), last years there has been a proliferation of virtual worlds and application related, and highlighted how social worlds, training worlds and corporate worlds have particular uses for education and training including in-world collaborative activities, such as collaborative assessment, pre-work training scenarios, role-play and others. Given the increased use of virtual worlds, more educational uses and dedicated education-based environments will appear supporting different and more specialized learning scenarios, enabling the formation of conceptual skills and greater reflection. For the purpose of determining the specific requirements and functionalities, a clear distinction must be made between general purpose virtual worlds and educational virtual worlds as they are very different topics. We must move towards a new approach that takes into account the singular features of educational virtual worlds. This new concept, whose conceptualization is proposed in this thesis, is Massively Multiuser On-line Learning (MMOL) platforms. This new mixed reality environment constitutes a still unexplored context for communication-enhanced learning, where synchronous and asynchronous communication skills in an explicit social setting enhance the potential of effective collaboration.

But apart from defining this concept, it is also important to present some methodological frameworks and best practices in order to normalize the use of MMOL platforms from conceptualization to concrete educational tasks.

As we detailed in previous chapters, this thesis reports three experimental studies of collaborative educational tasks in an MMOL setting from a holistic point of view.

The effort of first study concentrates on the analysis of group's role-play to improve group's skills. This experience was carried out by 21 graduate students enrolled in university courses in technology-mediated teaching and learning. In this experience, the students' group undertook a collaborative task about Learning Object evaluation using the mainstream Learning Object Review Instrument (LORI), which is based on a Convergent Participation Model (CPM). The same experience was carried out using a conventional LCMS (Learning Content Management System) platform with the aim of contrasting the outcomes and interaction patterns in the two settings. This study makes use of Social Network Analysis (SNA) measures to describe the interactions between tutors and learners. By dwelling on the advantages of immersive environments, SNA indexes revealed that these interactions were rather dense and that student participation was rather broad-based in the case of the MMOL.

The second study is about teachers' role-play in order to increase teacher's skills in psycho-pedagogical support for high school students. We put forward a proposal to encourage the use of 3D scenarios where teachers can improve their teaching-pedagogical skills for situations of cultural and ethical concerns that require a high level contextualization. We organize the study and improvement of those skills related to diversity, equity and inclusion in education. This study is centered on teachers and students of secondary education enrolled at the Castilla La Mancha (Spain) high schools. The ultimate aim is to demonstrate whether the MMOL platforms can improve such skills training teachers in virtual reality simulations. Study makes use of Descriptive Statistics and Standards Performance Continuum (SPC) test (Doherty, Hilberg, Epaloose, and Tharp, 2002; Hilberg, Doherty, Epaloose, and Tharp, 2004), to define use of diverse standards in a teaching improvement process and to highlight the importance of using multiple standards simultaneously in real or virtual simulation-based learning activities. Results suggest that MMOL platforms contribute a more effective teachers' control of school problematic situations and cases.

The third study proposes the establishment of a learner's role-play to improve learner's skills. Foreign languages' learning is the focus of the report because can serve as an appropriate context to analyze self-directed learning strategies and the culture of Lifelong Learning. The goal of this research is the creation of an integrated technology platform that enables the creation, development and deployment of contents and activities for teaching Spanish in an educational virtual world. Such environment promotes an immersive, creative and collaborative experience in the process of learning Spanish. In order to assess the validity and reliability of this technology we used the Technology Acceptance Model (TAM). The ultimate intention is to measure the acceptability of MMOL platforms for foreign languages learning.

All studies were carried out using a prototype of MMOL platforms built around an interactive and collaborative 3D space. In the first two above-mentioned cases, the collaborative space was called "*MadriPolis*". In the latter case, we built ad hoc space called SLRoute Island.

The results suggest that MMOL platforms can be used in collaborative tasks as a means to enhance both tutor/learner interaction patterns and the strength of the group's relationship. Furthermore, MMOL platforms can create a stimulating atmosphere around a collaborative creative learning process, also because this technology builds on a pre-existing common interest by users in the multi-user 3D videogame culture.

7.2 Integrated discussion

This discussion must be preceded by a reflection. It must be pointed out that MMOL platforms and its application is still maturing. Moreover, almost exclusively, the studies have been concerned one-time use of MMOL platforms by any particular group of participants, and there is no information on how these participants respond to the technology over the long term. Therefore, the summarized discussion given below present a snap-shot, hopefully, serve to guide further research on the optimal use of MMOL platform in education.

Next table (Table 24) shows a summarized view of the three studies carry out in this thesis.

Feature	First study *(Learning Object assessment)*	Second study *(Teacher's skill improvement)*	Third study *(Spanish language learning)*
Research Subject	Group's activities to improve group's skills	Teacher's activities to improve teacher's skills	Student's activities to improve student's skills
Purpose	Collaborative task about Learning Object evaluation using the mainstream Learning Object Review Instrument (LORI), which is based on a Convergent Participation Model (CPM)	Teachers' tasks in order to increase teacher's skills in psycho-pedagogical support for high school students, encouraging the use of 3D scenarios where teachers can improve their teaching-pedagogical skills for situations of cultural and ethical concerns that require a high level contextualization	The implementation of an integrated technology platform that enables the build, development and deployment of contents and activities for teaching Spanish in MMOL platforms.
Objects	Graduate students enrolled in university courses in technology-	Counselors in the educational guidance field and secondary school	Undergraduate and continuing studies foreign students at University of Alcalá

	mediated teaching and learning	teachers	
Sample	21	2 counselors and 20 secondary school teachers.	35
Methodological / Pedagogical framework	4D Framework (de Freitas & Oliver, 2006; de Freitas et al., 2010) for collaborative purposes	Bloom's taxonomy (Bloom, 1956), Banks' four approaches (Banks, 1994) and Ford-Harris matrix (Ford and Harris, 1999)	TAM theories and extended research model.
In-world assistance	On-line tutor- and self-directed learning	On-line tutor- and counselors-directed learning	Self- and Bot-directed learning
Method and tasks	Triangulation and a multiple-case study approach (Stake, 2006). Each case is based on contrasting the evaluation of a Learning Object in two settings: the MMOL setting and a conventional setting using an LCMS and asynchronous interaction.	Triangulation and a multiple-case study approach (Stake, 2006). Additionally activity centers (Hilberg, Chang, and Epaloose 2003) where school counselors, experts and teachers carried out role-play activities. The study focused on the comparative analysis of performed activities in a real context against MMOL platform.	Computer Assisted Language Learning (CALL) (Peterson, 2009) and TAM theories (Davis, 1989) and extended factors. Cognitive walkthroughs around educational virtual world.
Gammification	Role-play with ad-hoc 3D learning objects and scripting.	Role-play and simulation with ad-hoc 3D learning objects and scripting.	Role-play and simulation with reutilized 3D learning objects and ad-hoc scripting.
Collaborative space	MadriPolis (realXtend server)	MadriPolis (realXtend server)	SLRoute (Opensim server)
Research method	Mutli-case method and Social Network Analysis (SNA).	Mutli-case method and Standards Performance Continuum (SPC) (Doherty, Hilberg,	TAM (Davis, 1989) and extended methods combined with Partial Least Squares (PLS)

		Epaloose, and Tharp, 2002; Hilberg, Doherty, Epaloose, and Tharp, 2004) combined with descriptive statistics and Analysis of Variance (ANOVA)	analysis.
Findings	Interactions between participants were rather dense and student participation was rather broad-based in the case of the MMOL platforms.	Role-play activities on MMOL platforms, where the SPC provides the standards against which teacher performance is measured, is an effective professional development strategy for working with teachers in public school settings with diversity problems	Cooperate and collaborate in an explicit social context, such as 3D educational environment, in combination with enhanced communication tools (chat, video chat or VoIP) and intelligent assistants (chatbots) play a pivotal role in user acceptance of MMOL platforms. These platforms have the potential to provide a rich, engaging, collaborative and enjoyable learning environment for foreign language learning.

Table 24. Integrated discussion

As we pointed above, one of the significant commonalties of our research method is building rich education places on MMOL platforms in order to create specialized simulations and role-plays on diverse curricular topics. The relationship between learners, their learning activities, and the environment in which it takes place is reciprocal: learners create an activity within a specific environment. Thus, we created three educational places - from the multi-case method perspective- and carried out their respective activities and collaborative tasks. The first place is called *MadriPolis* and we used it to practice students' skill to enhance the depth of student ability in collaborative evaluation tasks. The same place was later used for the second case, but with a slightly different focus. This place is now the backbone of teachers' skills improvement in areas like diversity, equity and inclusion in education. The third place is called SLRoute and we used it for foreign language learning. Moreover, SLRoute offers a means of gaining a deeper understanding of other cultures, in particular The Way of St. James (Camino de Santiago) culture, which can serve as a basis for building better understanding between persons and communities. In this way, an informal learning network exists and the learning can be more broadly shared. This place and in-world-based activities involve more than just learning foreign languages.

This thesis has pointed out three studies of the use of MMOL platforms for educational issues. In the current transition to a new education for a new era, traditional instructional approaches have been called into question. Instead of memorization, it should be emphasized on the higher-level thinking skills needed to construct and apply knowledge. Students would be the protagonist in their learning process, enhancing the meaning of what has been learned and contextualizing the practice and theory. Students must learn to locate, interpret and creatively combine information, and to define and to cope with the increasing complexity of challenges. Additionally, education is no longer seen as something limited to a physical space or a certain period of time in a person's life. Instead, thanks to educational technology and methodological approaches we may be able to look beyond traditional classrooms as distinguishing characteristic of industrial society.

In conclusion, our three studies confirm that MMOL platforms and educational virtual worlds could be a key to the subsequent development of innovative contexts and student-centered methodologies to the education of the new era.

7.3 Future work.

There are many areas for further researches. As mentioned earlier, an important question is to extend studies in order to examine the impacts of the same findings over time.

According to Magee (Magee, 2006) the weaknesses of educational simulations are the need for a considerable amount of research. A lack of realistic models inside the simulation, unprofessional behavior by players, unrealistic levels of complexity in the environment and questionable transfer of skills from the virtual world to the real one could be an important drawback of this proposal. Many of the criticisms about simulations and educational games are common complaints for many poorly presented and poorly designed educational resources. It is not the concept of simulated-based learning that needs to be evaluated as much as their appropriate design and use. For this reason, future work in this area should focus on making high quality 3D objects repositories, and methodological and pedagogical guidelines to role-play activities implementation in other educational fields not included herein.

Other outstanding issue is that e-learning standards might not seem immediately relevant to a discussion about educational simulations. Standard-based learning 2D objects often come with a set of philosophical assumptions that will affect the kinds of design, development and deployment tools that are available to an instructional designer. Traditional e-learning standards are still relevant but it will be necessary to ensure that these standards do not restrict the ability of simulations to be developed to address current and future situations as well. It is therefore important to consider that other future work is the development of new 3D objects' standards, such as MOL (Minimum Object of 3D Learning) or RMOL (Reusable Minimum Object of 3D Learning).

Other relevant questions for further research could be: (a) Are MMOL platform cost-effective? (b) For what type of educational objectives or material is MMOL platforms best suited? And where is not suited? (c) How to improve MMOL platforms requirements to better suit to tablet platforms or haptic devices? (d) How to improve in-world security? (e) How to improve *gammification* of MMOL contexts? Other issue concerns the integration of MMOL platforms and Web. Already there are several browser and plug-ins that can be used for semi-immersive viewing of MMOL scenarios, although these browsers only support a minimal interaction with the 3D context. However the main goal here is to allow participants to collaborate in educational activities using a full 3D interface that make it possible and easier to involve all contents and functionalities of the Web 2.0. In this respect, further research about how to integrate augmented reality, geographical locations, the Internet of things and new interfaces, like motion sensing input devices, are necessary in a short term.

We want to conclude by saying that we have found evidence confirming the hypothesis that MMOL platforms offer the chance for more intense participations among group members and individuals than traditional learning settings like conventional LCMSs. MMOL platforms appear to be more appropriate for putting into practice collaborative and cooperative learning experiences. However, it is still necessary to consider how these possibilities depend on factors such as suitable training in the virtual context, the adoption of a correct pedagogical framework, and the use of an adequate virtual world server, 3D learning objects, scenarios and storyboards.

Appendix A. *Notations and Vocabulary*

This section provides a description of the acronyms, abbreviations, terms, notations, etc. frequently used throughout the thesis. It should be noted that some definitions below may depend on each other and many of them will be further explained in the next chapters. The terms are intentionality alphabetically unordered because the conceptual relationships between terms aids to their comprehension.

A.1 Educational Games and virtual worlds related:

- ***Virtual Reality*** (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary environments.
- ***Virtual World*** (VW), computer-based simulated environment through which users can interact with one another and use and create objects, normally in 3D formats; these users take the form of avatars visible to others.
- ***Mirror World*** is a representation of the real world in digital form. Differs from virtual worlds in that these have no direct connections to real models and thus are

described as fictions, while mirror worlds are connected to real models and lay nearer to non-fiction

- ***Augmented Reality*** (AR) is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or geo-referenced data.
- ***Mixed Reality***, (MR) is a term that refers to the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time. A mix of reality, augmented reality and virtual reality.
- ***MUD***, Multi User Dungeon, with other variants like Multi-User Dimension and Multi-User Domain, is a multiplayer real-time virtual world, usually text-based.
- ***Educational MUD***, MUD designed for educational purposes rather than gaming or chat.
- ***MOO,*** Muds Object-Oriented, are network accessible, multi-user, programmable, interactive systems well-suited to the construction of text-based adventure games, conferencing systems, and other collaborative software.
- ***MMORG***, Massively Multiplayer Online Role-playing Game, (also called **MMO** and **MMOG**) is a genre of role-playing video games in which a very large number of players interact with one another within a virtual world. They are played on the Internet, however, not necessarily

games played on personal computers. Most of the current videogame consoles include the possibility of developing MMORGs.

- ***Educational games,*** games that are explicitly designed to teach about certain subjects, reinforce development, expand concepts, understand an historical event or culture, or assist learners in learning a skill as they play. The most elaborated educational games make use of virtual reality and include most of the tools and frameworks of MMORG.
- ***CAVE,*** recursive acronym of Cave Automatic Virtual Environment, an immersive virtual reality environment where projectors are directed to more than two walls of a room-sized cube.
- ***2D GUI,*** two-dimensional Graphical User Interface, is the computer-based generation of digital images and by techniques specific to represent them on the Cartesian or Euclidean plane. 2D graphics models may combine geometric models or vector graphics, digital images or raster graphics, text to be typeset, mathematical functions and equations. These components can be modified and manipulated by two-dimensional geometric transformations such as translation, rotation or scaling.
- ***2.5D GUI***, also referred like "pseudo-3D" or "perspective ¾", 2D graphical representation and techniques which

cause a series of images or scenes to appear to be three-dimensional (3D) when in fact they are only two dimensions. The term "2.5D" is also applied to 3D games that use polygonal graphics to render the world and/or characters, but whose gameplay is restricted to a 2D plane. The human interaction "inside the world" is mainly restricted to a 2D computer screen, stereo sound, keyboard and mouse

- ***3D GUI***, graphics that use a three-dimensional representation of geometric data, often Cartesian, that is stored in the computer for the purposes of performing calculations and rendering 2D images. 3D computer graphics rely on many of the same algorithms as 2D computer vector graphics in the wire-frame model and 2D computer raster graphics in the final rendered display. In computer graphics software, the distinction between 2D and 3D is occasionally blurred; 2D applications may use 3D techniques and 3D may use 2D rendering techniques. 3D graphics creation falls into three basic phases: 3D modeling, layout and animation, and rendering.
- ***3D Modeling***, describes the process of forming the shape of an object. There are two sources of 3D models, those that an artist or engineer originates on the computer with some kind of 3D modeling tool, and models scanned into

a computer from real-world objects. Models can also be produced procedurally or via physical simulation. Basically, a 3D model is formed from points called vertices (or vertexes) that define the shape and form polygons.

- ***Layout and animation***, before rendering into an image, objects must be placed in a scene. This defines spatial relationships between objects, including location and size. Animation refers to the temporal description of an object, i.e., how it evolves and deforms over time. Popular methods include *key-framing*, inverse kinematics, and motion capture. These techniques are often used in combination.
- ***Rendering,*** converts a model into an image either by simulating light transport to get photo-realistic images, or by applying some kind of style. The two basic operations in realistic rendering are transport, that is, how much light gets from one place to another, and scattering, that is, how surfaces interact with light. This step is usually performed using 3D computer graphics software or a 3D graphics APIs. Altering the scene into a suitable form for rendering also involves 3D projection, which displays a three-dimensional image in two dimensions.

- ***Texture***, is a bitmap or raster image for adding detail, mapping graphics or color to a computer-generated graphic or 3D model.
- ***Polygon*** is an area formed from at least three vertexes (a triangle) that defines the essential elements of a 3D object. A four-point polygon is a quad, and a polygon of more than four points is an n-gons. The overall integrity of a 3D model and its suitability to use in animation depend on the structure of the polygons.
- ***Mesh*** or ***3D Mesh*** is a 3D object representation consisting of a collection of vertices and polygons which may be imported directly in virtual worlds or MMOL Platforms as a 3D object.
- ***Render Engine*** also referred like "Game engine" or "Renderer" is a logical context (program and associated tools) to generate an image from a model or a scene file. A scene file contains objects in a strictly defined language or data structure; it would contain geometry, viewpoint, texture, lighting, and shading information as a description of the virtual scene. Though the technical details of rendering methods vary, the general challenges to overcome in producing a 2D image from a 3D representation stored in a scene file are outlined as the graphics pipeline along a rendering device, such as a Graphical Processing Unit (GPU).

- ***Avatar*** is the graphical 3D in-world representation of the user or the user's idealization or character that can be customized by him/her. Normally, the criteria avatars have to fulfil in order to become useful can depend to a great extent on the age of potential users.
- ***Gamification*** is the use of game design techniques, game thinking and game mechanics to enhance non-game contexts, particularly educational contexts.
- ***Immersive context***, 3D GUI that includes 3D technology which is becoming more common in the consumer market, such as 3D video-game consoles, 3D televisions, 3D projectors, etc., along with a fully immersive interface based on improved devices and supplements which are not so common in the field of mainstream users, as is the case of CAVE or haptic devices.
- ***MMOL***, Massively Multiuser Online Learning, a genre of immersive context specifically adapted for educational purposes and includes VR, AR and MR techniques. A complex definition of this term is above-mentioned.

A.2 Learning Object Evaluation related:

- ***Learning Object is*** any digital resource that can be reused to support learning (Wiley, 2001).
- ***MOL,*** *Minimum Object of 3D Learning*, an atomic mesh or similar format aimed to a clear educational purpose that can be easily imported in a MMOL platform.

- ***RMOL,*** *Reusable Minimum Object of 3D Learning*, MOL characterized by their versatility and the ease with which it can adapt itself to distinctive educational contexts.
- ***LORI,*** *Learning Object Review Instrument*, individual evaluation tool to rate and comment on the quality of a learning object. LORI allows reviewers to rate and comment on nine items (version 1.5): content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability and standards compliance.
- ***Content quality,*** refers to veracity, accuracy, balanced presentation of ideas, and appropriate level of detail of the evaluated learning object.
- ***Learning goal alignment*** refers to alignment among learning goals, activities, assessments, and learner characteristics of the evaluated learning object.
- ***Feedback and adaptation,*** adaptive content or feedback driven by differential learner input or learner modeling.
- ***Motivation,*** ability to motivate and interest an identified population of learners.
- ***Presentation design***, Design of visual and auditory information for enhanced learning and efficient mental processing.

- ***Interaction usability***, ease of navigation, predictability of the user interface, and the quality of the interface help features.
- ***Accessibility***, design of controls and presentation formats to accommodate disabled and mobile learners.
- ***Reusability***, ability to use in varying learning contexts and with learners from different backgrounds.
- ***Standards compliance***, adherence to international standards and specifications: LOM, SCORM, IMS, etc.
- ***CPM, Convergent Participation Model***, is a two-cycle model designed to boost the efficiency and effectiveness of collaborative evaluation. In the first cycle, participants with diverse and complementary areas of expertise individually review a set of learning objects using LORI. The first cycle is completed asynchronously within a period of few days. In the second cycle, the participants come together in a moderated discussion using a synchronous conferencing system. During the discussion, participants adjust their individual evaluation in response to the arguments presented by others. At the end of the meeting, the moderator seeks consent of the participants to publish a team review synthesized from the mean ratings and aggregated comments (Vargo et al., 2003).

A.3 Data Analysis and collection related:

The terms that we are used to analyze data and results are the next:

- ***Social Network*** is the representation of a social structure, community, or society made of nodes that are generally individuals, groups, organizations, or other information/knowledge processing entities. Our thesis is based in the use of personal and behavioral social networks.
- ***SNA, Social Network Analysis,*** is the mapping and measuring of relationships and flows between social network nodes. The results are primarily presented in a target diagram. The nodes in the network are the people or groups while the links show relationships or flows between the nodes. SNA provides both a visual and a mathematical analysis of human relationships (Valdis, 2011).
- ***Node or actor*** represents the persons or groups that are going to be analyzed. Normally, nodes are referred to as circles. The sum of all nodes denotes the ***net size***.
- ***Ego-centric network*** or "personal" networks, a network with a focal actor (the "ego") and others who have connections to the ego.
- ***Link or tie or edge*** shows the relationships between nodes. Links are represented as lines.

- ***Flow*** is the direction of the link. The links could be unidirectional or directed, and bidirectional or undirected. A node without flow is called isolated node.
- ***Strength of a link*** is a quantitative assessment or weight of a flow. Values between any pair of nodes are included in the ***adjacency matrix***. When the flow value is the same in both directions the adjacency matrix is called symmetric.
- ***Clique***, a maximal complete sub-network containing three actors or more. It is complete in the sense that every actor in the sub-network is directly connected to every other actor in the same sub-network. It is maximal in the sense that we cannot add another actor from the network without making it incomplete.

  The next figure (Figure 34) shows any examples:

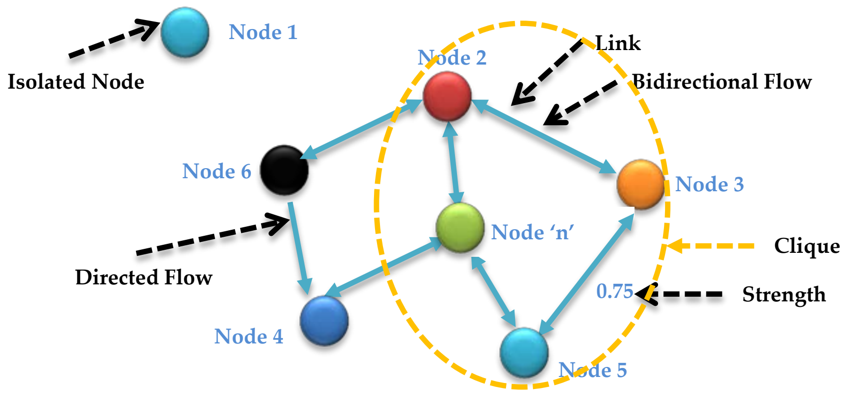

Figure 34. Network components.

- ***Path*** between two nodes is any sequence of non-repeating nodes that connects two nodes. The shortest path between two nodes is the path that connects the two nodes
- ***Density***, the proportion of direct links in a network relative to the total number possible. Describes the general level of linkage among the nodes in a network.
- ***Node's (in-) or (out-) degree*** is the number of links that lead into or out of the node. In unidirectional graphs are identical.
- ***Centrality*** refers to a group of metrics that aim to quantify the importance or influence of a particular node within a network based on nodes' in/out-degree. Common methods of measuring this property include betweenness centrality, closeness centrality, eigenvector centrality, alpha centrality and Freeman's degree

centrality. In this thesis it is very important to determine the position of the on-line tutor in the collaborative evaluation process. For each participant this was done using both Freeman's degree and betweenness.

- ***Betweenness centrality*** identifies an actor's position within a network in terms of its ability to make connections to other pairs or groups in a network. A node with a high degree of betweenness centrality generally: holds a powerful position in the network, has a greater amount of influence over what happens in a network, represents a single point of failure—take the single betweenness spanner out of a network and you sever ties between cliques.
- ***Freeman's degree*** measures the network activity of the actors, that is, the proportion of all the others with whom they communicate.
- ***Case studies method*** refers to analyze of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more methods. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame — an object — within which the study is conducted and which the case illuminates and explicates. (Thomas, 2011).

- ***Triangulation or cross examination***. Involves using multiple data sources in an investigation to produce understanding. This technique allows ensure that an account is rich, robust, comprehensive and well-developed. In our thesis we made use of three data sources as log events, on-line surveys and direct observations.

As a summary, the next figure (Figure 35) shows the data analysis and collection process used in this thesis:

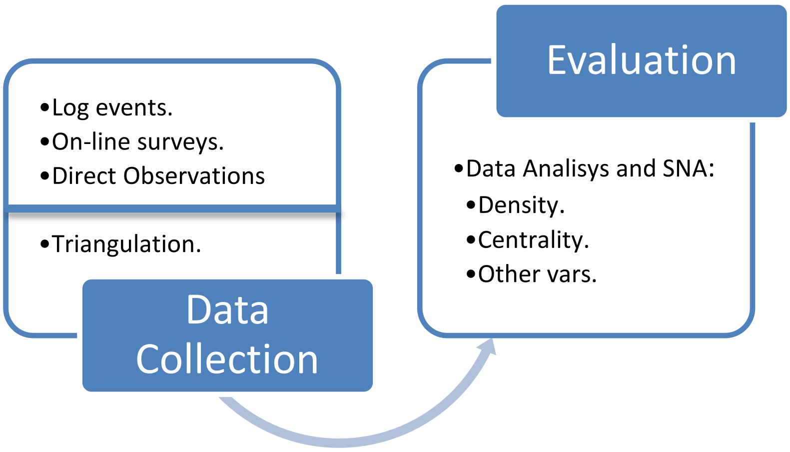

Figure 35 . Data Analysis and collection method.

A.4 TAM method related:

- ***Perceived usefulness (PU)*** is the degree to which a person believes that use of technology will produce better outcomes (Davis, 1989).

- ***Perceived ease of use (PEoU)*** is the degree to which a person believes that using a particular system would be free from effort (Davis 1989).
- ***Attitude***: Individual's positive or negative feeling about performing the target behavior (e.g., using a system).
- ***Behavioral intention***: The degree to which a person has formulated conscious plans to perform or not perform some specified future behavior.
- ***Computer anxiety***: The degree of an individual's apprehension, or even fear, when learner is faced with the possibility of using computers.
- ***Computer playfulness***: The degree of cognitive spontaneity in microcomputer interactions.
- ***Computer self-efficacy***: The degree to which an individual beliefs that he or she has the ability to perform specific task/job using computer.
- ***Effort expectancy***: The degree of ease associated with the use of the system.
- ***Facilitating conditions***: The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.
- ***Image***: The degree to which use of an innovation is perceived to enhance one's status in one's social system.

- ***Job relevance***: Individual's perception regarding the degree to which the target system is relevant to learner job.
- ***Objective usability***: A comparison of systems based on the actual level (rather than perceptions) of effort required to complete specific tasks.
- ***Output quality***: The degree to which an individual believes that the system performs his or her job tasks well.
- ***Performance expectancy***: The degree to which an individual believes that using the system will help him or her to attain gains in job performance.
- ***Perceived enjoyment***: is the degree to which using the new system or technology is perceived to be enjoyable in its own right, aside from any performance consequences resulting from its use.
- ***Perceived costs***: The concerns associated with the costs of purchasing the necessary equipment for the use of one technology.
- ***Perception of external control***: The degree to which an individual believes that organizational and technical resources exist to support the use of the new system.
- ***Perception of personal efficacy***: Self-efficacy to use a technology refers to the perception an individual has of his capacities and abilities to use this technology.

- ***Result demonstrability***: Tangibility of the results of using the innovation.
- ***Social influence***: The degree to which an individual perceives that important others believe he or she should use the new system.
- ***Subjective norm***: Person's perception that most people who are important to him think he should or should not perform the behavior in question.
- ***Voluntariness***: The extent to which potential adopters perceive the adoption decision to be non-mandatory.

Appendix B

(We used this questionnaire in both experiences and cases)

Q1. I received interesting information about this type of experience.

Q2. Based on my experience, I would like to use this platform in the future

Q3. If possible I would like to use this type of platform shortly.

Q4. Participating in this type of experience gave me insights into the basics of on-line collaborative tasks

Q5. I lost track of time while participating in the experience.

Q6. I become unaware of my surroundings while participating in this type of experiences.

Q7. I temporally forgot worries about everyday life while I participated in this experience.

Q8. After this experience I want to learn more about the use of this platform in collaborative tasks.

Q9. This type of experience is fun.

Q10. I had fun during this experience.

Q11. I connected with these people...

Case "A"	☐St A1	☐St A2	☐St A3	☐St A4	☐St A5	☐St A6	☐St A7	☐St A8	☐St A 9	☐St A10	☐St A11
Case "B"	☐St B1	☐St B2	☐St B3	☐St B4	☐St B5	☐St B6	☐St B7	☐St B8	☐St B9	☐St B10	

Q12. How do you rate the relationship between you and your classmates in this experience?

Case "A"	St A1	St A2	St A3	St A4	St A5	St A6	St A7	St A8	St A 9	St A10	St A11
Value1											

Case "B"	St B1	St B2	St B3	St B4	St B5	St B6	St B7	St B8	St B 9	St B10
Value1										

(1) Likert scale ranged from 1 (minimum) –5 (maximum)

Q13. How do you rate the relationship between you and the online tutor/s?

Case "A"	On-line Tutor
Value[1]	

Case "B"	On-line Tutor
Value[1]	

(1) Likert scale ranged from 1 (minimum) –5 (maximum)

Q14. How do you rate this platform's improvement of on-line collaboration against traditional learning (face to face or similar)? (1)

(1) Likert scale ranged from 1 (minimum) –5 (maximum).

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