

“The Evolution of e-Learning in the Context of 3D Virtual Worlds”

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Abstract: Information and Communication Technologies (ICT) offer new approaches towards knowledge acquisition and collaboration through distance learning processes. Web-based Learning Management Systems (LMS) have transformed the way that education is conducted nowadays. At the same time, the adoption of Virtual Worlds in the educational process is of great importance, not only for the researchers in the field of Web-based Education, but also for the educational community that is interested in applying ICT in education. The main motivation for studying the potential of Virtual Worlds applications in education stems from the capabilities they offer to create a cyberspace where users can interact with other participants (through their avatars) or objects, creating new experiences that are not often feasible in the real world. Within this context, the fundamentals of learning theories have to be analyzed, in order to study their impact on e-learning and Virtual Learning Environments design. The currently available Virtual-World platforms are being presented and qualitatively assessed. Subsequently we focus on Sloodle, which bridges the characteristics of the Moodle LMS with the Open Simulator 3D virtual world functionality.

Keywords: e-learning, virtual worlds, LMS, sloodle

1. Introduction

Information and Computer Technologies have become a constituent part of every human activity (social, economic, cultural etc.), offering innovative information/communication channels and evolution on the existing methods of working, learning and thinking. Especially in the world of education, the challenges focus on extracting useful information through huge piles of data and transforming them to modern and functional knowledge.

According to the principle that efficient learning does not demand the educator and the student being present at the same time in the same place, Distance Learning contributes to the need for education or training through the establishment of Open Universities and the rapid evolution of e-learning. The software tools that support distance learning are Learning Management Systems (LMSs). LMSs are met in the literature (Britain and Liber, 1999) as software tools that combine: computer and communication functionality, on-line methods of learning content provision and educational process management tools through an integrated web-based learning environment. Also, they offer supportive functionality to the educational procedure (i.e. through posting assignments and allowing for participation in synchronous or asynchronous chats or/and through bulletin boards) (Westera, 2005).

Additionally, the development of 3-dimensional Virtual Worlds plays a central role in distance learning (Kahiigi et al. 2008; Freitas 2006; Freitas 2008) gathering 3 main features (Dickey, 2005): i) create the illusion of a 3-dimensional environment, ii) support the usage of avatars as virtual representations of human users, iii) offer communication and interaction tools to their users.

The evolution of Virtual Worlds to their current form has its roots in the rapidly evolving field of electronic games. The first effort of creating a Virtual World is dating back to the '80s where text-based single-player games were developed (Salt et al., 2008).

Virtual worlds are designed to offer real-time communication tools, interaction capabilities and collaboration empowerment (Dickey, 2005a). Thus, students can gain experiences infeasible to live in the real world. Within this framework (Dillenbourg et al., 2002) studied the characteristics of Virtual Learning Environments (VLEs) and identified several similarities with the characteristics of Virtual Worlds. This led to the belief that although Virtual Worlds were not intended for use as VLEs, they satisfy most of their relevant functionality offering the potential to be involved in the educational procedure.

The increased interest in 3-dimensional Virtual Worlds resulted in the development of numerous similar environments. Relevant research efforts studied their usage potential in education (Eschenbrenner et al., 2008). Some of the most popular 3D VW platforms which can be applied in education are presented in Section 4.

As these virtual environments become more and more popular in educational community, the necessity of their interconnection with LMSs appears as a mandatory step towards future evolution and user adoption. Within this framework, Sloodle (Simulation Linked Object Oriented Dynamic Learning Environment) is an environment that interconnects Virtual Worlds with Moodle LMS by combining their characteristics towards learning support.

The purpose of our paper is to study contemporary learning theories and their application in Virtual Learning Environments. More specifically we will provide:

- A survey on the evolution of learning theories.
- A detailed presentation of LMSs functional specifications and their limitations.
- An analysis of the advantages that stem from the usage of Virtual Worlds in education.
- A thorough analysis of the virtual world platform characteristics.
- A study on the necessity to interconnect LMSs with Virtual Worlds through Sloodle.
- A case study of Sloodle tools in order to justify its usage potential.

2. The evolution of learning theories

E-learning and ICT supported distance education tend to become an integral part of not only primary and secondary schools but also for universities and organizations of private and public sector. Therefore, researchers and stakeholders recognize the fact that approaching the field only through a technological perspective does not guarantee successful knowledge transfer. Thus, the analysis of pedagogical and learning principles under the prism of e-learning techniques appears to be inevitable.

Nowadays, most e-learning systems consist of several modules and functionality (e.g. content and participants' management, operational environment, communication etc.). Furthermore, they are loosely or not interconnected with no explicit educational objective overruling them. Moreover, within such a distant learning environment, the students should have full control of where, when and how the necessary knowledge can be obtained. An educational path that would be comprised of the content, the educators and the technological tools, should discourage stakeholders from being distracted by numerous available choices that can be utilized. Also, a fundamental feature of such a system is to guide course development and direct relevant didactic plans implementation that have to be followed by the learners. The tradeoff involved in user guidance is between posing burdens in navigation and aimless wandering within the cyberspace (Dietinger and Maurer, 1997).

Mayes (2004) argues that there are no models or learning theories exclusively designed for e-learning but only "electronic" enhancements of them. Furthermore, it is clear that although teachers and students are innovative regarding ICT in education, many efforts have not been widely accepted due to deficient design and implementation outcomes. This problem becomes more complicated as technology evolves and Virtual Worlds are more and more applied as educational tools. Virtual worlds offer the opportunity to the learners to be engaged in activities that continuously measure their performance and assess their apprehension. One should not ignore the fact that according to Dewey (2008), real learning should be based on experiences and in order to gain new knowledge continuous testing and assessment are necessary. From this point of view, traditional learning theories are omnipresent and should not be ignored no matter how intensive the technological progress is.

In this context, education aligns with the needs of the new era that requires open, flexible and learner-centered learning systems where physical presence of trainers and trainees at the same place is not mandatory.

The influence of new technologies and their application in education (see **Figure 1** below) led support to the claim that interconnecting the educator with the learner through internet can form a virtual classroom (Keegan, 1995). According to Simonson (2000) distance education is a typical education system where students are located in remote places and communicate with the educator through interactive means and systems.

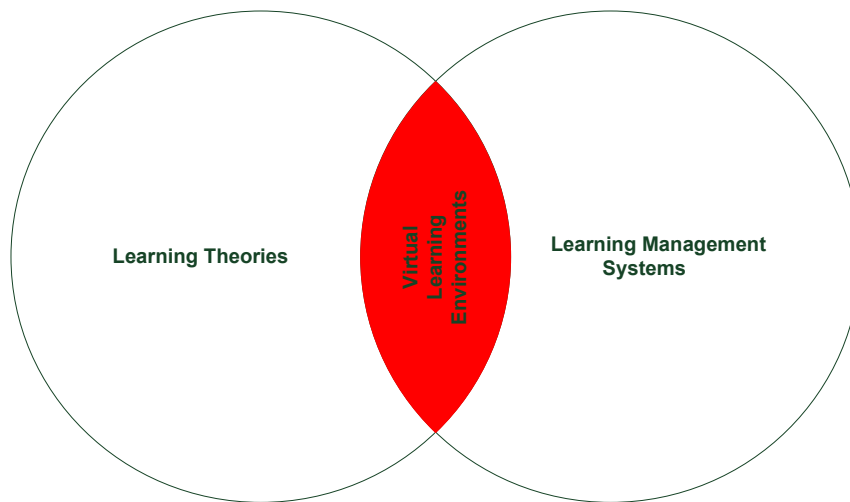


Figure 1: The convergence of ICT with learning theories

The dynamic nature of web-based educational software and the radical changes in the field of learning technologies led to a new view of distance learning that resulted to e-learning. E-learning is wide enough and encompasses every form of distance learning that is employing internet or digital resources. Clark & Mayer (2007) define e-learning as a digitally supported and Internet mediated education that gathers the following characteristics:

- The educational content is closely related to the learning objective.
- Employs educational methods to facilitate learning.
- Makes use of words and images in order to supply content.
- Can be guided by the educator (synchronous e-learning) or designed for individual studying (asynchronous learning).
- Constructs new knowledge and skills that are tightly connected with personal objectives.

The main challenge of e-learning is to enable courses development according to confirmed human learning procedures. Also, it is widely accepted that the influence of ICT on education is optimized when it is appropriately integrated in education practice (Schank & Cleary 1995). Towards this objective we should focus on educational plan design and not on content presentation. This suggests that we are asked to explicitly describe the learners' navigation path within the e-learning environment. Thus, it is necessary to review the relevant learning theories that influence the design and development of learning environments. Also we will study their evolution in order to comply with the contemporary needs of education.

The benefits arising from ICTs empower the traditional methods of course design asking for collaboration among students and requiring their participation in producing a deliverable towards course completion. On the contrary, traditional classroom based teaching procedures conclude with a summary from the teacher ignoring the ICT potential that facilitates students to express themselves through images, audio-video and case studies that may carry a holistic answer to the questions posed in "class".

According to (Piaget, 1972; Papert and Harel, 1991) constructivism approach suggests that knowledge is constructed upon past experiences and the mental constructions or beliefs that anybody uses in order to understand objects or facts. However, Vygotsky (1962) focused on the communicative and cultural dimension of learning, attempting a social-political approach. A progression of those two theories is social constructivism (Holmes and Gardner, 2006) that introduces a third dimension in the interaction between learner and its environment. This dimension is based on the other participants (learners and educators).

It should be mentioned that in our world of interrelated data, the nature of information that someone holds and the value of the knowledge that will be produced are significant. Moreover, an individual cannot be based only on its own experiences for knowledge acquisition. In the digital era, connectivism (Siemens, 2004a) fills the gap caused by technological development and the new learning environment. Knowledge is regarded as a network of nodes and connections regularly rearranged and reconnected able to produce new knowledge.

Regardless of the technological progress, a common objective of all learning theories is to describe the effort needed in order to acquire knowledge. Cognitive, social-cultural and connectivism theories often focus on different aspects of learning but finally lead to the adoption of collaborative learning as the prevailing one (i.e. virtual learning environments (3-dimensional or not) are a typical example - (Konstantinidis et al., 2010)) through an evolutionary procedure. Collaborative Learning theory preceded computers and is based on a combination of Piaget and Vygotsky theories, composing the relevant social and constructivist features (Dillenbourg et al., 1996; Scardamalia et al., 2006) in a form where two or more people learn or try to learn together.

The main objective of computer supported collaborative learning is to carry out communication among stakeholders (scholars and teachers) and support social interaction (Dillenbourg and Traum, 1999). Collaborative procedures become feasible through collaborative learning networked environments that are designed for distributed and distance learning support (Anderson and Jackson, 2001). Furthermore, (Shih and Yang, 2008; Konstantinidis et al., 2009, 2010) prove that collaborative learning can be empowered through the usage of 3D Virtual Worlds establishing a new e-learning tool.

3. Learning management systems (LMS)

Learning Management Systems (LMSs) (that are frequently referred as Digital Class Management systems or Virtual Learning Environments) are software systems that appeared during the second half of 1990s and combine computer-based communication functionality, online support of educational content and tools that manage the educational procedure as an integrated web-based learning environment (Britain and Liber, 1999).

LMSs are widely used for educational and training purposes not only because they are on the edge of technology but also, because they:

- Eliminate temporal and geographic restrictions from learning procedure.
- Offer flexibility during the learning phase.
- Allow for interaction between educators and students.
- Provide reusable resources that are easily maintained.
- Fulfill the relevant requirements and specifications for efficient, quick and educationally correct teaching.

Consequently, LMSs should be used from educators and organizations in order to:

- Create and manage on-line courses.
- Support collaboration among students.
- Provide motivation and resources for creating team spirit.
- Manage questions, quizzes and tests for assessment purposes.
- Manage virtual classrooms where students are geographically distributed and communicate only through internet.

According to Ellis (2009) the main features met in a LMS include: i) Coordination and management of electronic classrooms, ii) Coordination and management of electronic courses – educational content and activities, iii) Personalization through individual profile support for each user, iv) Management of registered students, v) Activities scheduling, vi) Communication between educators and students, vii) User activities monitoring and viii) Reporting functionality.

3.1 Learning management system platforms

Currently, e-learning market is inundated with LMSs that implement most of the features mentioned above. A classification according to these features is out of the scope of this paper. However, a categorization according to the acquisition cost (i.e. commercial or free open source) is depicted in **Table 1**.

The most popular commercial LMSs are: eCollege (www.ecollege.com), Blackboard (www.blackboard.com) and Saba (<http://www.saba.com/>). There are many other commercial platforms (like desire2learn - www.desire2learn.com) but these three prevail in the e-learning market. They were primarily designed to fulfill the requirements of universities and they developed strong brand name after being upgraded and redesigned for years.

However, the vast majority of institutions turn to freely available and open source solutions that meet high degree of configuration and adaptation potential. Such a choice, keeps the cost of course management at a minimum rate, allowing the academic community to adjust such a platform through in-house development of add-ins or innovative tools (Franklin and Hart, 2006; G. Papadourakis, Yiannis Kaliakatsos, 2006)

The table below depicts the most widespread LMSs.

Table 1: A list of widespread LMSs

LMS	Category (Commercial/Free Open Source)	WebSite
Blackboard	Commercial	http://www.blackboard.com/
Desire2learn	Commercial	http://www.desire2learn.com/
Ecollege	Commercial	http://pearsoncollege.com/index.learn
JoomlaLMS	Commercial	http://www.joomlams.com/
IntraLearn	Commercial	http://www.intralearn.com/Default.aspx
Saba	Commercial	http://www.saba.com/
Atutor	Free Open Source	http://www.atutor.ca/
Claroline	Free Open Source	http://www.claroline.net/
Moodle	Free Open Source	http://www.moodle.org/
DotLRN	Free Open Source	http://www.dotlrn.org/
OLAT	Free Open Source	http://www.olat.org/

The LMS of choice, for the experimental environment of our case study is Moodle. This decision stems from its open source and freely available characteristics, while one should not ignore its continuous evolvement and upgrade on the basis of social constructivism learning theory. Also, Moodle offers all these capabilities that educators can use to form a virtual electronic class (e.g. Choice and Glossary tools). Finally, it satisfies the requirement for easy access on its database and its source code. Research efforts, have focused on interconnecting Moodle with OpenSim that is the free and open source equivalent to Second Life (Konstantinidis et al., 2010) and will be further investigated in sections 5 and 6.

3.2 Limitations of learning management systems

A critical issue concerning the LMSs is the fact that although stakeholders consider them as e-learning cornerstones, they are not learner or educator – centered (Siemens, 2004b). This results to course-centered functionality rather than to learner-oriented. The learners are bound to specific activities with predefined functionality and time limits. Also, they have no control on the prerequisites for the evolution of their own education. Another weakness of LMSs is the absence of interaction between (i) learner – content, (ii) educator – educator (if applicable), (iii) educator – learner. Although they include a variety of communication support channels between educators and learners, they are solely used as document repositories (Kemp and Livingstone, 2006). On the other hand, only experienced educators use the majority of the offered communication tools. Thus, it is clear that LMSs do not fully support interactive learning. Furthermore, the rare usage of multimedia content is another deficiency of LMSs.

According to Siemens (2004b), LMSs are not efficient to support learner’s performance monitoring and knowledge management. The LMS tools do not enhance the independence of the learners who are not encouraged to take responsibility of their own learning. The course-centered approach of LMSs prohibits learners from defining their own objectives and deadlines and also discourages them from organizing their tasks and their time usage. Also, it prevents cooperation with other users towards creating documents or multimedia content. Furthermore, the learners have to follow a predefined educational path as specified

within the LMS (Quality Improvement Agency, 2008; Illinois Online Network, 2010). Besides, as mentioned by Hughes (2001), the support of the learner's skills is a necessary part of a person's self-awareness and self-esteem.

4. Virtual Worlds – characteristics, functionality and examples

Currently available 3D Virtual Worlds are sophisticated platforms that support a set of human activities and interactions, enriching the way we learn, work and socialize. The adoption of Virtual Worlds has been facilitated through internet-based applications that allow for file sharing, virtual meetings, seminars/lectures and scientific experiments (De Freitas, 2008).

Until the wide establishment of communication networks, Virtual Worlds were restricted to what someone could see through a personal computer monitor (Sutherland, 1965). The idea of copying and reconstructing an environment as a Virtual World was born in late '80s. Brooks (1988) claimed that computers were powerful enough so as to construct cutting edge models of complicated physical environments. Furthermore, Wooley (1993) and Dibbell (1998) refer to Virtual Worlds in plural suggesting that a computer allows access to a set of virtual worlds and not a single one.

A preliminary definition of Virtual Worlds supplied in (Barfield et al., 1995) states that: *“Virtual Worlds are interactive, 3-dimensional virtual environments supported by a computer that implement multiple senses which can be used within”*. Bartle (2003), gives a more descriptive definition introducing some new features: *“Virtual Worlds offer automated rules that enable users to change the world they live in. Users are represented by avatars and interact with each other in real-time. Finally, a Virtual World is shared and characterized of persistence, preservation and duration as it keeps exist and evolve even if the participants do not interact”*. The definition supplied by Dickey (2005a) focuses on the fact that 3-dimensional virtual environments differ with each other although most of them implement three common characteristics (illusion of 3D environment, representation through avatars, interaction and communication tools).

According to the definitions cited above there is not a single concrete definition that encompasses all the characteristics of Virtual Worlds. These characteristics strongly depend on the point of view, but a common set includes: i) Operation in Real-time (synchronous), ii) Awareness of Space, iii) World's size, iv) Persistence, v) Networks of people, vi) Use of Avatars, vii) Immersion, viii) Interactivity, ix) Use of Objects (along) with scripting, x) Support of various multimedia types and xi) Communication potential.

Apart from their features categorization, Virtual Worlds can also be classified according to their social characteristics (Franceschi et al., 2008) and the functionality they offer (De Freitas, 2008). The main axes of the former category are Virtual Game Worlds and Virtual Open Culture Worlds. The distinct dimensions of the latter category are: Role Playing Worlds, Social Worlds, Working Worlds, Training Worlds and Mirror Worlds.

4.1 Virtual World platforms

The increasing interest in 3D Virtual Worlds drives innovation in numerous relevant environments and their application adoption in education through case studies (Eschenbrenner et al., 2008; Hew and Cheung, 2010). Open Simulator, Second Life, Active Worlds, Project Wonderland and Open Cobalt are some Virtual World platforms that can be applied in any educational procedure. In the following paragraphs we examine their main characteristics and perform a qualitative comparison.

Open Simulator platform development originated as soon as Linden Labs Inc distributed their Second Life client software under GNU LGPL license, making it widely available to users and programmers. Some preliminary efforts resulted to a freely available, open source project named Open Simulator (OpenSim). An Open Simulator installation can host simulated virtual environments, much the same with Second Life due to the adoption of its messaging protocol. This characteristic makes OpenSim accessible through the most popular SL viewers. User registration and account creation are totally free.

OpenSim provides three modes of operation: Standalone, Grid and Hypergrid mode (Fishwick, 2009). In Standalone mode, each user is authorized and interacts with a server before entering the world. One can create and execute as many Regions as it wants, but only in the same machine. On the contrary, Grid mode

gathers a set of services that are usually referred as UGAIM (User, Grid, Asset, Inventory, and Messaging) that comprise the data services. Region services may be executed in different machines (i.e. different regions) and make use of the UGAIM services that are hosted on a separate server (OpenSim Data Service Server). Hypergrid mode implements the idea of a Web of virtual worlds allowing their interconnection over the internet. In this mode, region administrators can place hyperlinks within their maps to regions maintained by others.

Active Worlds is one of the first virtual worlds with more than 2.000.000 downloads of its browser (Active Worlds browser) and 1.000.000 daily hits of the main Active Worlds Universe. The users of Active Worlds can have unique names, enter the world (or universe in Active Worlds terminology) through the Active Worlds browser and navigate in 3D virtual environments built by others. The presence of Active Worlds in education is noteworthy. Active Worlds Education Universe (AWEDU) is a complete universe that focuses on strengthening research and development in education. To this direction it cooperates with numerous educational institutes from all over the world. Educators in AWEDU are capable of defining concepts and theories, teaching in classroom, giving presentations and studying the social aspects of education.

Second Life is one of the most popular Social Virtual Worlds developed by Linden Lab Inc. Second Life hosts more than 1,500,000 user accounts and keeps growing. It gathers characteristics of Virtual Worlds, gaming and messaging applications. Its most significant feature is the scalability potential it possesses. Users may integrate new assets and functionality within the virtual world. In Second Life, a user can interact with other users, navigate to islands (private regions of variable surface) and use sophisticated services. All this functionality allows the usage of Second Life as an advanced educational tool. It follows the client – server model and the open source viewer can be configured at will.

Open Cobalt platform is technologically based upon Croquet project (Smith et al., 2003). In early 2007 it was freely distributed as an open source software under Croquet SDK. Open Cobalt allows the construction, access and shared usage of Virtual Worlds over LAN's or the Internet with no server installation needed (unlike Second Life architecture). Open Cobalt is more scalable compared with other commercially available virtual world platforms mainly due to the adoption of peer-to-peer technology to support any kind of interaction. On the contrary, the majority of the rest of the platforms adopts the widespread centralized architecture making use of a dedicated server.

Another popular platform is Open Wonderland that was initially developed by Sun Microsystems but since 2010 it is supported by Open Wonderland Foundation. Open Wonderland users can communicate with high fidelity sound, share desktop applications and cooperate on educational, business or social issues. One of the project milestones is its scalable environment.

4.2 Platforms comparison

The following table summarizes the aforementioned platform characteristics. OpenSim and Second Life are the platforms that both support the Linden Scripting Language in order to meet the demand of interconnecting them with Moodle. This necessity excludes the rest platforms from being considered candidates for adoption. Additionally, Second Life was also rejected due to the cost of buying virtual land, group creation and functional configuration that are essential in educational procedure. On the contrary, all this functionality is offered for free by OpenSim allowing the development of innovative services and their configuration. Furthermore, the adoption of open source software should be the first choice for the following educational reasons:

- The trainee notion and imagination should not be restricted.
- The trainee should not have in hand software that offers every single answer.
- The educational procedure should develop that trainee's curiosity.
- Knowledge should be freely available to anyone with no barriers posed.
- Usage benefits and open research issues of Virtual Worlds in education

During the last decade internet technologies had a significant impact in the educational procedure. They supported the development of various emerging technologies, such as Virtual Learning Environments, that empower interactive learning. 3D Virtual Worlds satisfy many characteristics of Virtual Learning Environments,

providing the potential of new educational experiences. At the same time they offer the appropriate tools so as educators and students cooperate towards efficient learning procedure.

Table 2: Comparison of 3D Virtual World platforms

	Active Worlds	OpenSim	Second Life (SL)	Open Wonderland	Open Cobalt
Open Source	No	Yes	No	Yes	Yes
Free of charge	As a visitor/ Yes	Yes / Yes	As a visitor/ Yes	Yes/ Yes	Peer – to Peer network technology
Programming Language	C	C#	C++	Java	Squeak/ Smalltalk
Support for Virtual Objects	Yes	Yes	Yes	Yes	Yes
Avatars	Yes	Yes	Yes	Yes	Yes
Configuration	Yes, for free	Yes, for free	Yes, with charge	Yes, for free	Yes, for free
Educational Tools	No, but there is a special Virtual World named AWEDU	Yes, Sloodle	Yes, Sloodle	No	No
Features	Internet browsing, on-line voice chat, instant messaging etc.				
	-	Easy content creation, scripts development by end-users		Application Sharing	

3D Virtual Worlds that provide user immersion, are a new educational tool that is applied both in traditional and distance learning procedures (Dickey, 2005b). They support constructivism by offering a wide range of usage potential not only to educators but learners too (Eschenbrenner et al., 2008). Another new trend in educational environments design is collaboration among stakeholders within a shared virtual space (Barab et al., 2000). Additionally, special attention should be paid to user created Virtual Worlds that usually form an ideal place for research and development.

The term Virtual Learning Environments – VLEs is wide enough and may be misleading as it can be used to define not only static systems (that can provide learners progress monitoring and content downloading) but multi-user Virtual Worlds too. Dillenbourg (2002), studied the characteristics of Virtual Learning Environments and identified a lot of similarities with Virtual Worlds justifying their employment potential in educational procedure. More specifically, VWs can advance teaching and learning processes through immersion, cooperation between users, realistic simulations and multi-channel communication.

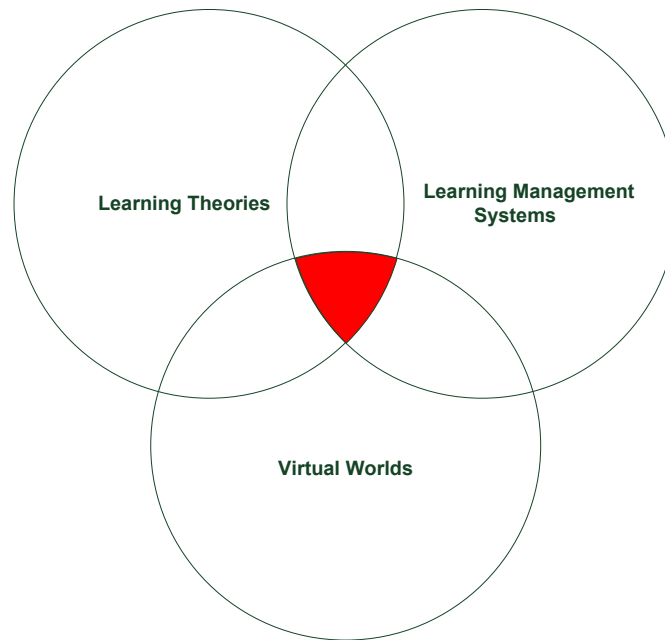


Figure 2: The convergence point of Virtual Worlds with traditional learning theories and learning management systems

A set of advantages have been pointed out in the literature and include: teaching and conducting educational activities in a secure environment (Dickey, 2005b; Conway, 2007; Goral, 2008; Graves, 2008; Ondrejka, 2008), the empowerment of cooperation and communication (Bronack et al., 2006; Peterson, 2006), engagement of trainees (Foster, 2007; Mason, 2007; Richter et al., 2007), the potential of using an alternative environment as a classroom or laboratory (Conway, 2007; Graves, 2008) and visualization of composite content (Barab et al., 2000).

Apart from the benefits mentioned above some research issues emerge regarding their wide application in nowadays educational procedure. These issues, among others, focus on: specifying high value educational applications (Mantovani et al., 2003; Foster, 2007; Schultze et al., 2008), cost-efficiency analysis and technology evolution (Mantovani et al., 2003), health and security (Bugeja, 2007), and user adoption (Barab et al., 2000; Siau et al., 2004). Any educational activities design should take into account these issues in order to be complete and successful.

Through a detailed analysis of Virtual Learning Environments we conclude that the integration of LMSs with VWs can lead to innovative e-learning environments able to support most of their features. Such an environment is Sloodle that will be further presented in sub-section 5.1.

5. The interconnection necessity between LMSs and Virtual Worlds

Traditional LMSs (that are often referred as Virtual Learning Environments) offer a wide range of services for educational activities support, courses management and students progress auditing. The majority of LMSs support most of these features. However, they pose some restrictions that cause substantial degrade on e-learning efficiency. These restrictions include: course-focused LMSs instead of learner-oriented, limited interaction potential, reduced capabilities of educator originated activities, loss of control from the student side preventing the development of independent educational skills. This causes LMSs, along with their tools, to contribute on content rather than educational procedures (Yasar and Adiguzel, 2010).

These restrictions of LMSs can be surpassed due to the tools offered by Virtual World platforms. Although VWs have not been designed in order to serve educational purposes, they possess the potential to create learner-centered environments than educator-centered ones. The educational process can be improved through learner-centered pedagogies and promoting constructivism and problem-based learning.

5.1 Sloodle: An interconnection plug-in between Moodle and Virtual Worlds

Virtual Worlds enhance the interaction and cooperation among users through immersive environments that are suitable for empirical and constructivist learning. However they do not support asynchronous cooperation of learners that are usually connected with a Virtual World in different time instances and tend not to provide support on course management and learners assessment. Moreover, in contrast to LMSs, VWs have limited capabilities of content storing and formatting. Additionally, some other functionality such as desktop sharing and presentations creation are not easy to accomplish.

Due to the fact that all the VW platforms do not offer a common and enriched subset of educational features, the need of interconnection among traditional LMSs and 3D Virtual Worlds is being increased. Kemp and Livingstone (2006) justified the necessity of such a system. Also, the environment has to assure compatibility with existing LMSs (e.g. Moodle) in order to allow data transfer (e.g. learners' catalogues, grades, educational content etc.). Sloodle is such an environment that boosts the connection of Moodle with Second Life and OpenSim (Figure 3).

Accordingly, it is safe to deduce that this software, through its tools, covers the functionality mentioned above.

5.2 Sloodle educational activities and tools

Sloodle consists of tools named Objects that have been programmed in the LSL language. The most significant objects and modules are:

- Sloodle Controller
- Sloodle Set
- Registration Booth

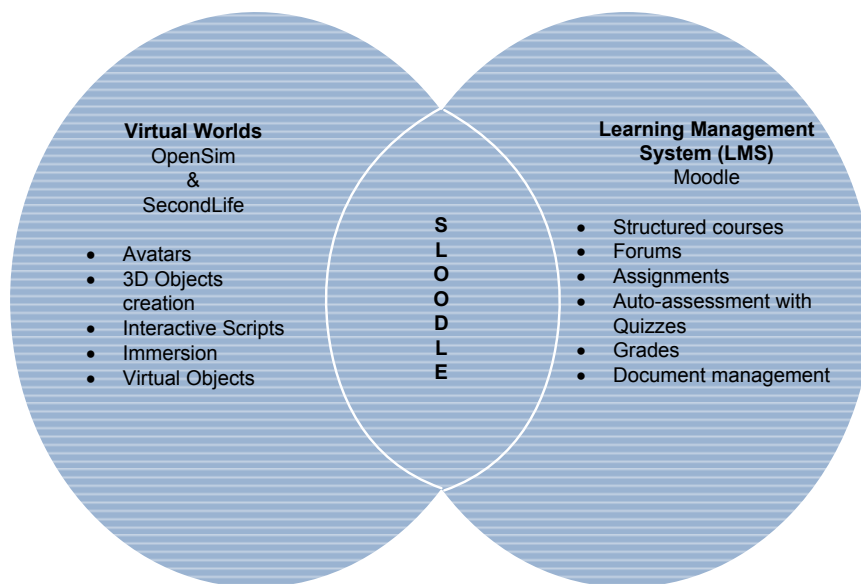


Figure 3: Sloodle Conceptual model

Based upon the analysis of Moodle educational culture and the usage advantages of virtual worlds in education we conclude that Sloodle allows the users to create four distinct categories of educational activities (Livingstone and Kemp, 2008):

- Role-playing and simulations
- Group-work and team building
- Events and presentations
- Constructive activities

Some tools that are used to support the educational procedure and implement the methods through which Moodle is embedded within a virtual world (Second Life or OpenSim) (Yasar and Adiguzel, 2010) are the following:

- Web Intercom, that interconnects public text chat in virtual world with a Moodle “chatroom”.
- Multi- function Sloodle Toolbar, that allows avatars (through Attachment) to update a Moodle Blog through the virtual world.
- Sloodle Presenter, implements the necessity for multimedia content presentation.
- Quiz tool, supports learner’s assessment both in virtual world and Moodle.
- Sloodle Quiz Chair, allows users to take multiple-choice tests of Moodle within the virtual world, receiving virtual feedback (i.e. the user rises while the answers are correct and lowers in case of wrong answers).
- Sloodle Pile On Quiz, enables a group of virtual world users to participate in multiple-choice tests that an educator has created in Moodle.
- Sloodle Metagloss, is being used of avatars in order to search for terms through a Moodle glossary that is part of the electronic class.

6. Case study: A Sloodle – based course in Virtual Worlds

The case study objective is to depict most of the educational features offered by Sloodle along with the relevant configuration efforts needed to form an appropriate experimental environment. It attempts to present the necessary steps that someone has to take in order to adapt existing Moodle-based course content to a 3D Virtual World environment.

The experimental environment of our virtual classroom was based on the OpenSim Archive (OAR) functionality. More specifically, we adopted the Educasim VW environment that is freely available on the internet (Odomia, 2009). Educasim is a virtual world implemented for educational purposes containing classes, lecture rooms etc. However, Educasim offers nothing else but the educational environment (the space where students may navigate in) and not the functional components of a classroom. All the necessary functionality was implemented by adopting Sloodle. Thus, its Registration Enrollment Booth was used to assist the registration of avatars in virtual classes. Some other Sloodle modules which were utilized include: Chat Activity, Sloodle Presenter, Quizzes, Choice and Glossary.

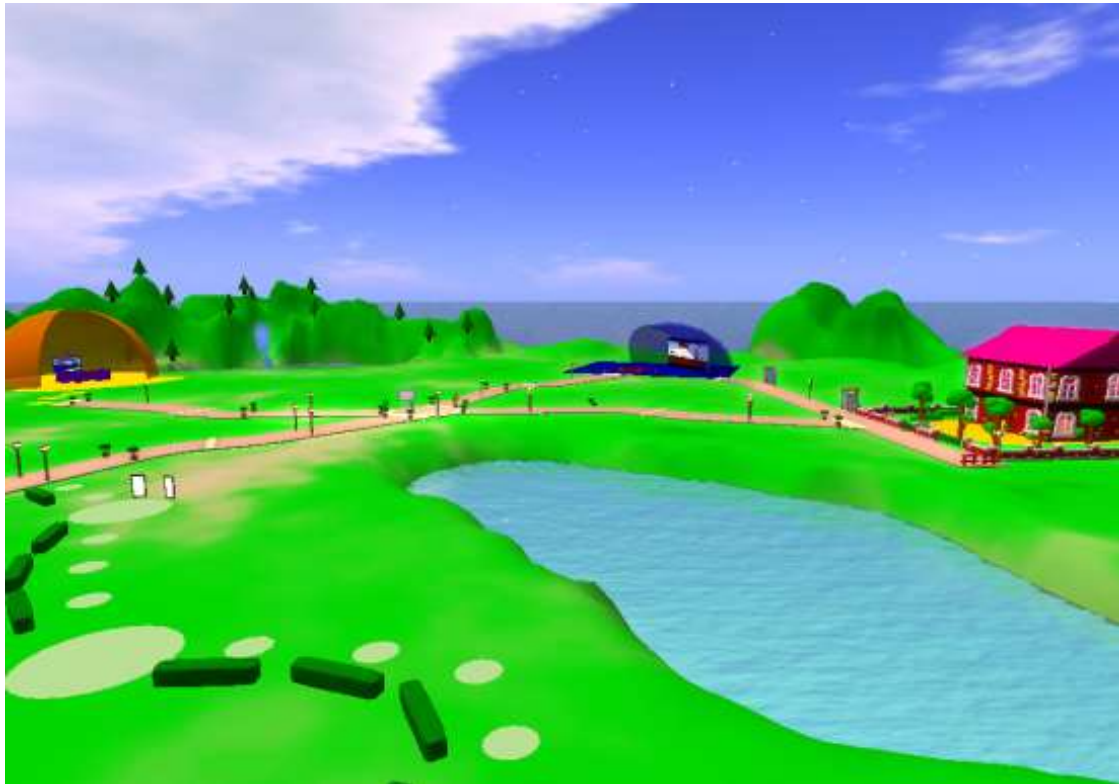


Figure 4: A representative instance of EducaSim virtual world

The learner-side educational functionality available for use will be depicted through a basic use case scenario. The main activities that will be described concern navigation, interaction with objects, communication, objects creation and avatars configuration within the virtual world. As soon as the educator carries through Sloodle configuration and virtual class implementation, the available functionality to the learner includes:

Virtual World browsing. Prior to their participation in Sloodle educational activities, learners have to be familiar with some navigation rules in virtual worlds. They can move their avatars within OpenSim virtual world by the navigation buttons on the graphical user Interface. Also, avatars can *Fly* (by pressing the relevant button), facilitating Virtual World navigation.

Interaction with Objects. Avatars can interact with virtual objects by clicking on them. In some cases they can sit on them by choosing the *Site Here* command (e.g. on *Quiz Chair*).

Communication. Avatars can communicate with each other through the *Chat* functionality.

Object creation. Avatars can create their own objects through the *Build* set of commands. The creator of a virtual object can define its copyright properties. Also it is able to implement scripts that may offer extra properties on virtual objects when associated with them.

Avatar configuration. The users can edit their avatar's appearance by choosing the *Appearance* command.

The following figure depicts the architecture of the adopted learning environment. Sloodle appears as a middleware among Moodle and OpenSim "translating" functionality between the two systems. Also, it is obvious that it is not a user interface. The user who wants to access the environment is obliged to use a web browser (for Moodle) or a virtual world client (such as Second Life or Hippo viewer, for OpenSim).

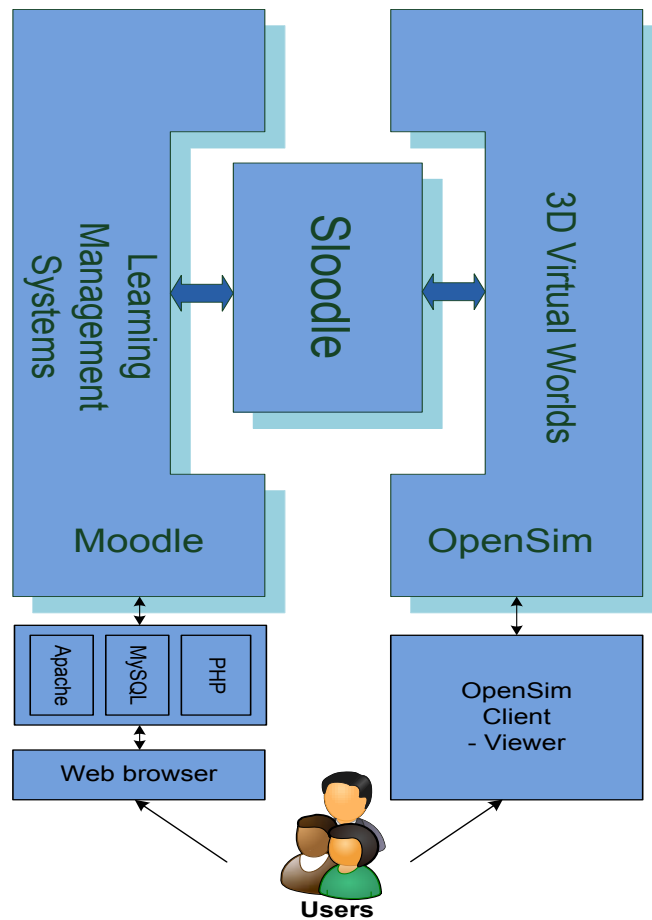


Figure 5: The architecture of a learning environment based on Moodle, OpenSim and Sloodle

6.1 A Sloodle-based course scenario.

Some typical educational activities offered by Sloodle which were implemented within this sample course context are the following:

- Registration – Learner admittance to the course
- Participation in lecture
- Participation in real-time chat.
- Glossary support
- Quiz participation.
- Voting.

The course selected to be taught is entitled “Introduction to WEB 2.0”. Its context was chosen due to the emerging relation of virtual worlds and Web 2.0 technologies on education.

The educational scenario within the virtual world was based on the flow met not only in a traditional class but in a LMS such as Moodle. This scenario includes: learner **registration** in a course, **study** of the educational content, **communication/chat** with classmates or the educator, **quiz based assessment**, and overall **course rating** (e.g. content quality).

Upon its admittance in EducaSim virtual world, the learner can read some useful directions about the activities sequence it should follow.

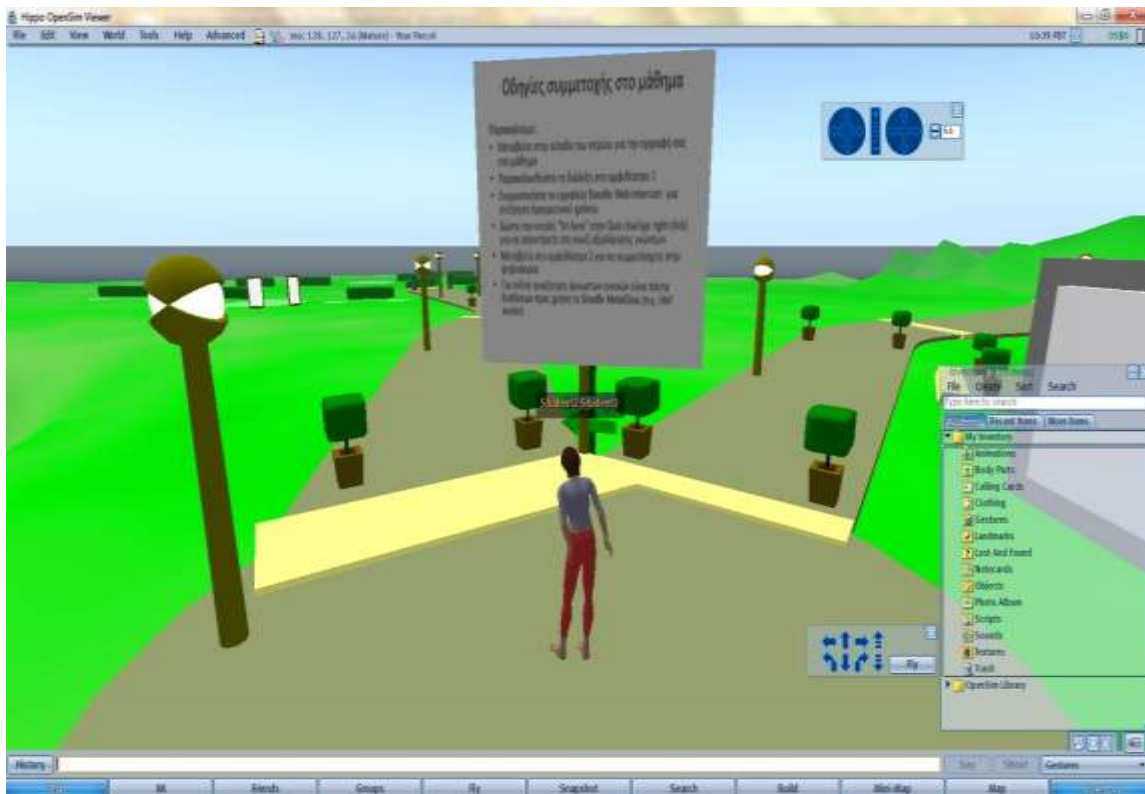


Figure 6: Directions notecard for learners

▪ **Registration and learner admission.**

The learner is called to spot the Registration Booth according to the supplied directions and get enrolled in a virtual class entering the user code it possesses for Moodle. After registration, the learner appears on the Moodle Avatar List (the Avatar List functionality is Sloodle based and not available in a simple Moodle installation).



Figure 7: User registration in virtual class



Figure 8: Moodle avatar list

- **Participation in lecture**

The learner, according to the educational scenario posed by Moodle, is asked to attend a lecture entitled: “Web 2.0”. The lecture room contains a Sloodle Presenter which allows lecture stream rate control through the relevant buttons at the object’s bottom.

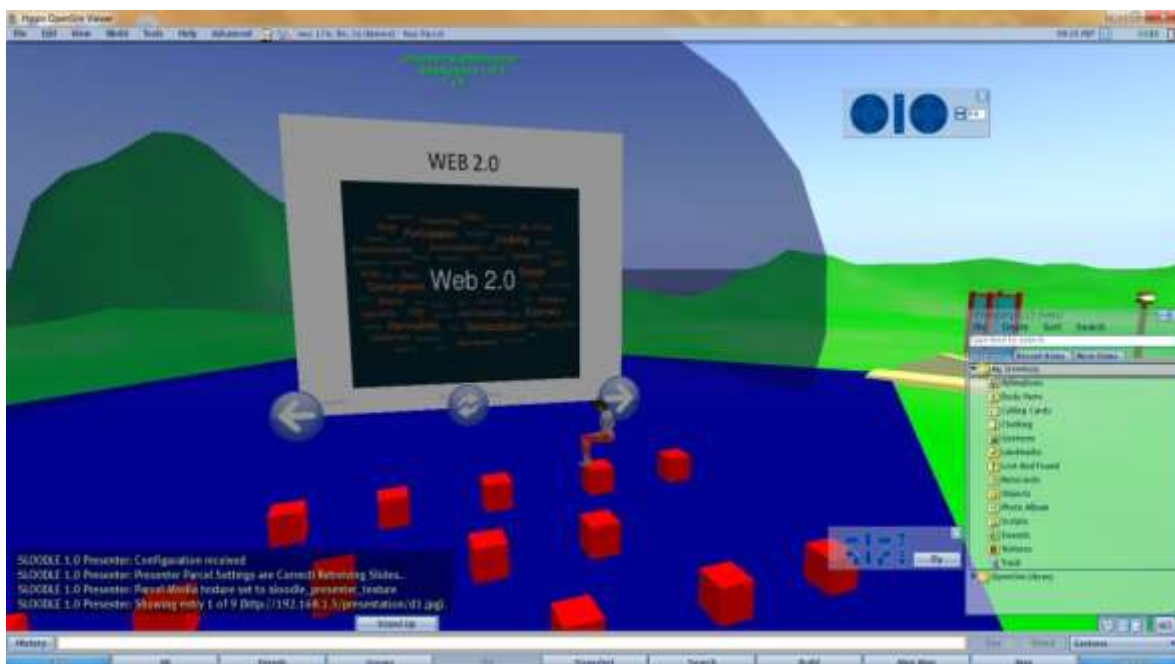


Figure 9: A Virtual World lecture attendance

- **Participation in chat**

After attending the lecture, the learner can make use of the Web-Intercom tool in order to raise questions or pose subjects for conversation. The Web-Intercom tool may bring in touch the learners with classmates or educators and also offers the ability for recording. By default, the conversations are being recorded in the relevant Moodle chat room and the educator’s presence is not necessary in virtual world.



Figure 10: Activation of conversation recording in Sloodle Web-Intercom



Figure 11: An example of interactive chat between educator and learner

Another tool the learner has in hand is Sloodle MetaGloss. A user can request the definition of a term from Moodle glossary, through typing *"/def* followed by a word or phrase. A card appears reporting the result of the query.

▪ **Quiz participation**

A learner's knowledge assessment is performed through the Sloodle Quiz Chair that is directly connected with a quiz already implemented in Moodle. Performance recording is also available for each participant. The visualization of the results into the virtual world is achieved through chair lifting for each correct answer. Results overview is also possible through the relevant Moodle quiz tool.

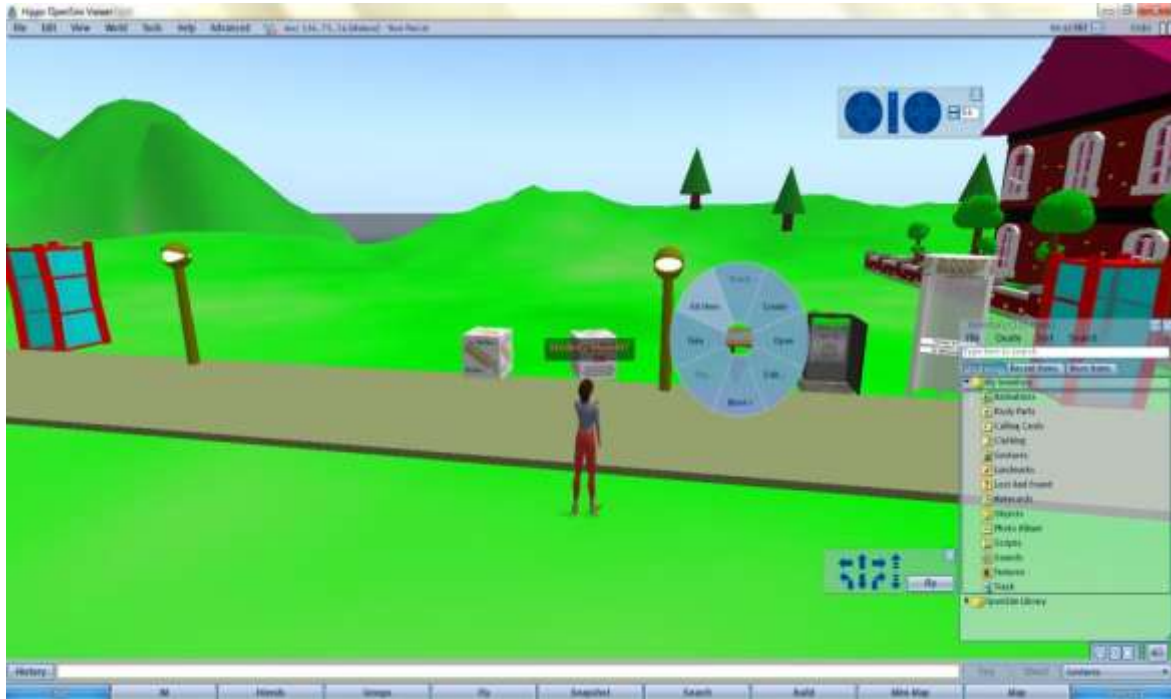


Figure 12: Taking a quiz through the “Sit Here” command



Figure 13: Answering a question and chair lifting

Attempts: 8

Showing graded and ungraded attempts for each user. The one attempt for each user that is graded is highlighted. The grading method for this quiz is **Highest grade**.

First name / Surname	Started on	Completed	Time taken	Grade/10	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Admin User	26 April 2011, 06:08 PM	26 April 2011, 06:09 PM	1 min	6	0/1	0/1	1/1	0/1	1/1	1/1	0/1	1/1	1/1	1/1
	26 April 2011, 07:09 PM	26 April 2011, 07:10 PM	46 secs	6	1/1	1/1	1/1	0/1	1/1	1/1	0/1	1/1	0/1	0/1
	28 April 2011, 07:07 PM	28 April 2011, 07:08 PM	1 min 4 secs	8	0/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1	1/1	1/1
	30 April 2011, 11:28 AM	-	open	-	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1
Evi Dimopulu	15 April 2011, 09:28 PM	-	open	-	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1
Student Student	26 April 2011, 10:02 PM	27 April 2011, 09:37 PM	23 hours 34 mins	2	1/1	0/1	0/1	0/1	0/1	0/1	1/1	0/1	0/1	0/1
Student1 Student1	29 April 2011, 12:18 AM	-	open	-	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1	-1/1
Student2 Student2	30 April 2011, 07:52 PM	30 April 2011, 07:55 PM	2 mins 19 secs	8	0/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1
Overall average				5	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1

Figure 14: Results overview in Moodle

- Voting

Upon completion of the educational scenario, learners are asked to participate in a poll about their impression of participating in a course offered within a 3-dimensional virtual world. The answers are being also recorded by the Moodle “Choice” tool.

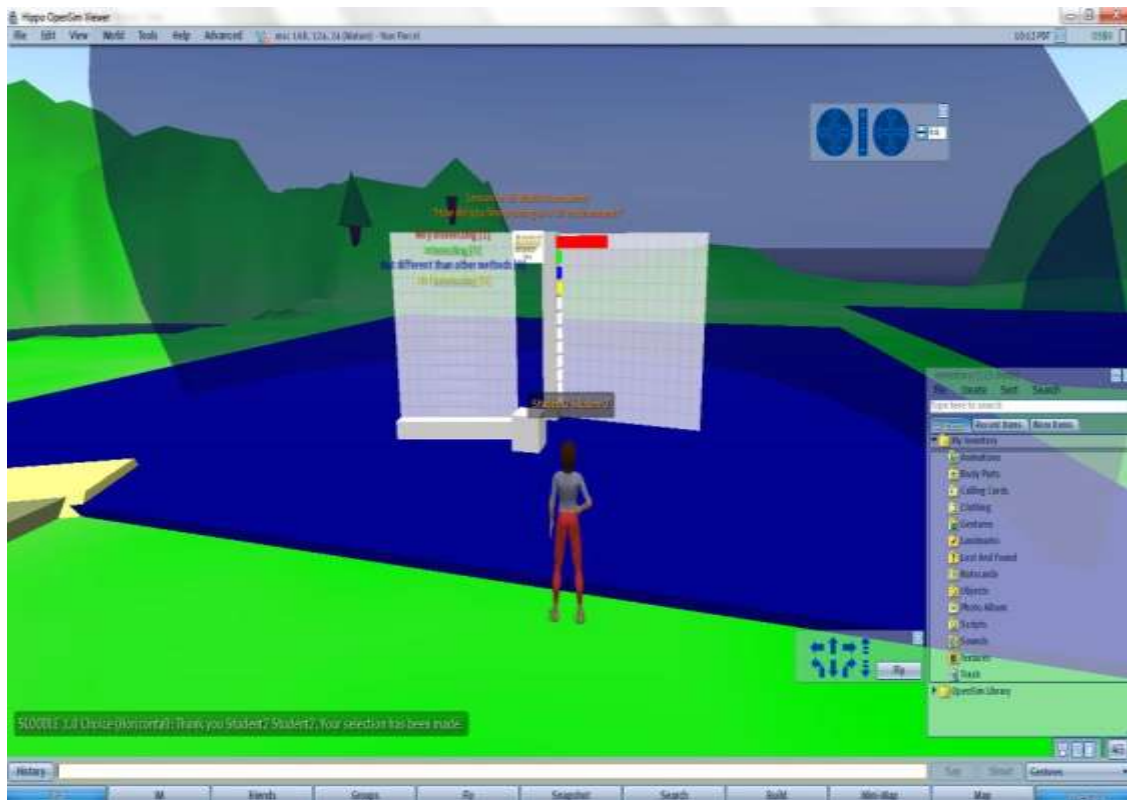


Figure 15: Participation in voting within a virtual world



Figure 16: Voting results overview from Moodle side

7. Conclusions

ICTs offer numerous dynamic tools able to provide educational activities that did not exist or could not be implemented in real classes. Their adoption in the educational procedure is not only a significant innovation but an interactive process that affects our perception about learning and teaching. At the same time the application of ICTs in education is being affected through boosting further research on the field.

ICTs in education lead more and more researchers to the adoption of constructivism learning theories within the context of distance and electronic learning. LMSs, like Moodle, which are based on the educational concept of social constructivism along with virtual worlds that encompass most of the VLEs features, can be utilized for educational purposes.

More specifically, VWs that implement constructivism and collaborative educational methods trigger the learners offering an appropriate environment through which anyone can acquire qualitative knowledge, interact with other learners or educators and actively participate in knowledge evolution.

It should also be mentioned that VWs are not a substitute of existing educational technologies, but a mean to support learners' engagement. The interconnection of a popular LMS (like Moodle) with VWs (like OpenSim) is not only important but interesting too. The interconnection can upgrade the existing capabilities offered by LMSs and VWs. That is the reason behind choosing to study the potential of Sloodle as a method for bringing together Moodle and OpenSim. At this time, research and development around Sloodle focuses on getting advantage of the characteristics met in both environments for benefit of the educational procedure.

Through a detailed analysis of Sloodle we conclude that it gathers a rich set of tools in order to interconnect Moodle courses with OpenSim virtual worlds. The interconnection focuses on combining Moodle characteristics (i.e. structured courses, chatting, projects assignment, quizzes etc) with virtual world characteristics (i.e. avatars, configuration potential, interaction, communication, immersion).

In conclusion, an experimental virtual class was setup on OpenSim and Moodle platforms as a feasibility study. Our work also presented the necessary technological infrastructure for future research on the field of VW supported LMSs. Next steps, should attempt to measure and analyze user adoption of such an innovative technology as Sloodle in order to pave the way for future platform enhancements that will be user-driven and will follow their needs.

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